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The Edison Motor. THE advent of a new motor is not generally a noteworthy event in these days, but when an organization like the Edison Company takes the field with a new machine something may appropriately be said. We show elsewhere in our columns the form of armature that has been adopted for the street car motor. Its good points will be apparent on a very casual examination, and its utilization for motor work is decidedly a step in advance. We hope, of course, that the time will come when armatures will not burn out; but experience has taught that it is not yet, and so long as accidents will happen the ability to replace a damaged armature coil easily and rapidly will be of value. The use of the regular Edison form of machine as a stationary motor is a rather radical change, but if it brings as many good qualities as the dynamo has shown the new comer will readily find a prominent place for itself. There is really no reason why there should be a special motor type, and manufacture is much simplified by the uniformity of design.

Contact Electricity. A BRIEF but interesting paper read at the British Association by Sir William Thomson deals with a practical application of that extraordinary phenomenon known as contact electricity. It seems that in the admirable multicellular form of electrometer often used as a voltmeter there is an error of reading due to the contact difference of potential between the aluminum needle and the brass cell, that amounts, to be sure, to only a small fraction of a volt, and can be readily allowed for, but it is noteworthy as a curious illustration of the really mysterious action that goes on between electrified metals. Contact electricity deserves even closer attention than it has as yet had, for, whatever may be its cause, we may feel well assured that when it is explained we shall know more about the real nature of electricity and electrical action than now; for with contact electricity may probably be explained the dynamics of electric charge, at present decidedly mysterious. These practical relations of abstruse points in electrical theory have been turning up quite frequently of late and ought to teach the real importance of investigations which at first sight might be supposed to belong to the realm of pure science.

Electric Telpherage. A BRIEF note on another page tells of the successful operation of a short elevated electric railway shown at the Edinburgh Exhibition. The idea of a flying car under perfect control throughout its course, and doing its work quite automatically, is really a very attractive one. But it would seem to be evident that the elevated wire rope construction is hardly adapted to securing the best results, and the transfer of passengers via the aerial short line appears decidedly unpractical. Most people would not care to trust themselves to the tender mercies of an irresponsible motor in any such fashion. Long and hard experience has taught that automatic operation of a complicated apparatus is extremely difficult unless the conditions of use are under perfect control. Just so soon as the usual sequence of circumstances is in any way interrupted there arises the need for a guiding intelligence. It is all very well to demonstrate that a given arrangement must work successfully, but there is always the tacit condition that no accidents shall interfere. There are places where telpherage could be applied with admirable results, and would prove a valuable addition to the resources of engineering, but so far as carrying animated freight is concerned, the possibilities are many, but we fear the probabilities are very few.

Storage Battery Traction. THERE seems just now to be a marked increase of interest in the use of the storage battery. At least half a dozen varieties of electric cars thus equipped are being thoroughly tried in an experimental way, aside from the three or four roads that have such a system in regular operation. The cars on the Fourth avenue line in this city are growing to be a conspicuous part of its equipment. By all means let the good work go on until something thoroughly practical is evolved. There is a good time coming in urban electric traction, and it behooves electric railway engineers to see that it is not unduly delayed by the advent of the cable abomination. This probably will soon obtain a resting place on Broadway, and will manage to set its fangs into other streets unless its attacks are vigorously combatted. Experience in other cities has shown only too plainly the dangers of the grip car, and a short trial on our crowded streets will bring conviction when it is too late. A street car that must move at a considerable speed when under headway and cannot be reversed in time of need is a constant source of peril to the public as the long list of accidents in Chicago shows with horrible distinctness. There is a magnificent opportunity for a storage or closed conduit system to come to the rescue. Even the usual overhead construction is far less objectionable than the uncertain and unmanageable cable.

Submarine Telephony. THE near prospect of a direct telephonic line between London and Paris was brought before the recent meeting of the British Association in a brief paper by Mr. Preece, who has done much to further the progress of telephonic communication of every sort. In the early days of the telephone there were high hopes of almost limitless application that gradually faded away as disturbing causes became apparent. Now, after careful investigation of the theoretical side of the problem, it has become evident that the telephone is not at all inapplicable to short submarine lines provided the cables are properly constructed. If both the resistance and the static capacity can be reduced so far that their numerical product will be something less than ten thousand, the transmission of speech will be good. A cable for submarine telephony must then be designed with this fact in view, and experience has shown that for lines of moderate length at least, success is quite attainable. But it is very plain that it is not possible to go on indefinitely in this way, for a point will soon be reached where the amount of copper would be prohibitive from a commercial point of view, or impossible conditions would be introduced by the permissible dimensions of the dielectric. It is safe enough to say, therefore, that we are very unlikely to have a telephone cable under the Atlantic, although for considerably shorter distances the electrical difficulties are not forbidding.

The Mechanics of Magnetism. EVER since the days of Ampère the energies of scientific men have been bent toward finding some rational explanation of the mysterious phenomena of magnetism. The questions to be answered were numerous, for the relations of magnetism to magnetizing force are exceedingly complicated. A comprehensive theory must explain all the facts, and it is not surprising that even the tremendous intellect of Maxwell paused, baffled before the task. And yet though he developed no satisfactory theory of magnetism he incidentally pointed, in one of his almost prophetic suggestions, the path that has led another far toward the truth. Weber's suggestion that the molecules of magnetic metals are always magnets and that magnetization consists in turning their axes in the same direction, was a very shrewd guess at the fact, but fails to explain the known phenomena of hysteresis, residual magnetism, and the like. Maxwell modified this hypothesis by supposing that a magnetic molecule, when its axis is deflected more than a certain amount, acquires a permanent set. This would explain the existence of residual magnetism, but fails satisfactorily to account for certain other peculiarities—the point of inflection in the permeability curve near the origen, for example. It has remained for Professor Ewing to take up the problem and bring it far nearer to a solution than ever before. The supposition made, as will be seen by a reference to the paper itself, to be found on another page, is that the molecular magnets are normally grouped under the influence of their mutual attractions, and that these groups are split up and the individual parts aligned by the magnetizing force. From this point of view the sudden increase of permeability through a certain range of induction corresponds to the condition of instability during the rearrangement of the molecules. We may thus regard a bar of iron as made of very heterogeneous groups of molecular magnets. Professor Ewing has illustrated this phase of the theory by studying the action of a magnetizing force on groups of little magnets pivoted to allow of free rotation. The new hypothesis accounts for the results of experiment in the most beautiful manner, and is a great advance in our knowledge of a very occult portion of science. It still remains, however, to account for the existence of that mysterious something we call magnetism in the molecule itself, a problem very closely allied to that presented by the other mysterious something which, for lack of a better name, we call electricity.

The Lineff Tramway. THOSE of our readers who are specially interested in electric traction will appreciate the paper read before the British Association by Mr. Kapp and published elsewhere in our columns. The author comments rather too gloomily on the immense difficulty of securing a proper system for conveying current to a moving car. We might very justly retort that while the English engineers have been racking their brains for the systems aforesaid the Americans have put nearly three hundred roads into successful operation. The overhead wiring has in practice proved to be well adapted for suburban service and far less objectionable in city streets than was at first feared. A little less extreme conservatism and a little more dashing enterprise would be a wholesome change of policy for our foreign cousins. But this aside; the exigencies of city electric tramway service have stimulated invention and have produced various underground methods of supply possessed of more or less merit. The storage battery has as yet failed to render us independent of more direct plans of operation, and, as a rule, the slotted electrical conduits have come to grief. There probably could be found places where insulation in such conduits can be at least partially maintained, but great difficulty would be experienced in selecting a locality wherein the climate would fulfill the above condition and at the same time be fit for human habitation. The Lineff system, described in detail by Mr. Kapp, is an ingenious attempt to dispense with anything like an open slot, and connects a special sectional rail to the underground supply cable by an electro-magnet carried on the car. To this end a magnet a trifle longer than the rail section is employed; the magnetic circuit is continued through the rail, and the strap iron switch and armature conveys the current from the supply cable in the tightly closed subway. At first sight the apparatus seems clumsy, but Mr. Kapp's tests have shown that its actual operation is quite satisfactory, and the amount of energy consumed by the magnetic circuit closer is not at all prohibitive. The insulation was only moderately good, but promised no severe losses, so that on the whole the apparatus could be said to be in good working order. Nevertheless, a line, the continuity of which depends on the reliability of innumerable electromagnetic contacts, will be looked at askance by the practical engineer who has a wholesome fear of repairs. The Lineff system, however, has a considerable interest from the fact that it is one of a type that has been evolved by the existing conditions. Of the same class is the Wheless electric railroad, recently tried in Washington. Several others are in the field, differing considerably in detail, but all having the common feature of a sectional-rail working conductor connected by automatic switches to an underground supply conductor. The general idea involved is good, but the enormous number of special switches operated by various magnetic or mechanical appliances constitutes a most serious objection in the eyes of the practical electrician. It is by no means impossible that this difficulty may be in some way avoided. Meanwhile the lengths of such experimental tracks are too small to show the general efficiencies of the respective systems, and it is but fair to suspend judgment until they have been put to the crucial test of commercial work. Only such trial can show their real merits.

A Novel Combination Electric Switch.

BY LIEUT. SAMUEL RODMAN, JR., U. S. A.

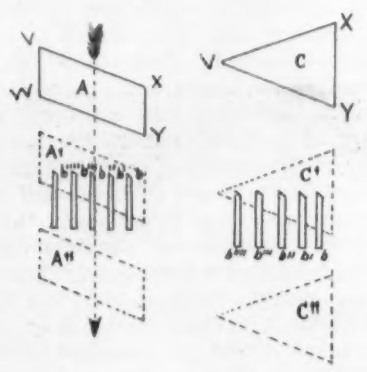
In presenting the following subject matter I am led to believe that it may possess sufficient interest and value to warrant at least a passing glance from the readers of THE ELECTRICAL WORLD. Hardly a day passes but some new design in the way of a double or single pole switch is brought out. The one which I have devised and will describe is neither, but may better be called a continuous combination switch.

As it possesses certain characteristics different from other switches, I shall first go into a little preliminary detail in order to make clear its functions and working. Referring to Fig. 1, let A represent a strip of metal, and b, b', b'', b''' and b'''' metallic springs, so arranged that when A is moved up or down in the direction of the arrow it will successively touch the metallic springs b to b'''' until it reaches a position indicated by the dotted line inclosing A', when it will touch all five of the springs b, b', b'', b''' and b''''. Move the metallic strip now to the position indicated by the dotted lines inclosing A'', and it will be seen that it will slide past the metallic springs in the same order that it moved on to them. So, taking the movement in detail, we have the metallic strip first touching the spring b; then b and b'; then b, b' and b''; then b, b', b'' and b'''; then b, b', b'', b''' and b''''; then b', b'', b''' and b''''; then b'', b''' and b''''; then b''' and b''''; then b'''', and finally sliding past all of them.

Referring to Fig. 2 let C represent another strip of metal, and b, b', b'', b''' and b'''', as above, metallic springs, and move C in the direction of the arrow to positions indicated by the dotted lines inclosing C' and C'' and it will be seen that it will successively touch the metallic springs from b to b'''', and will slide past them in exactly the reverse order from b'''' to b. Taking this second example in detail we have the metallic strip C first touching the spring b; then b and b'; then b, b' and b''; then b, b', b'' and b'''; then b, b', b'', b''' and b''''; then b, b', b'' and b'''; then b, b', and b''; then b and b'; then b, and finally sliding past all of them.

By giving different shapes to the metallic piece which slides on and off the springs other different combinations could be brought about, but the two general cases given will show that for the five springs taken there are nine different combinations of contact between the metallic piece and springs; or taking the more general case and letting n represent the number of metallic springs, and the different combinations of contact between the metallic piece will be represented by the general expression $2n-1$.

For a simple case to show how such an arrangement as I have described will apply as an electrical switch, I will refer to Fig. 3, which represents a dynamo, one pole of which is connected to the metallic strip and the other to one terminal of each of a group of five lamps, the other terminal of the lamps being each connected to one of the metallic springs, b to b'''', as in Fig. 1. Now, suppose A to be moved in the direction of the arrow head, and, from contact with b, lamp C will burn; then, from contact with b and b', lamps C and C'; then, from contact with b, b' and b'', lamps C, C' and C'' and so on until A has moved past the springs and no lamps are burning. By this arrangement then we have 1, 2, 3, 4, 5, 4, 3, 2 and 1 lamps burning, or,



FIGS. 1 AND 2.—RODMAN'S COMBINATION SWITCH.

in other words, we have varied the intensity of the light gradually and continuously. The example taken of the continuous gradation of light is presumably the simplest case. Many other applications may be made, substituting for the single lamps different coils of a shunt-wound dynamo or motor, or groups of lamps.

The number of metallic springs chosen in the figures is five, but it can readily be seen that by increasing the size of the metallic strip A, Fig. 1, and C, Fig. 2, almost any number of metallic springs can be accommodated, and also a greater number of circuits controlled continuously and successively.

As a suggestion to those interested in the subject, I would propose the use of such a switch in connection with a shunt-wound motor on electric cars, in order that the current from the main dynamo may be thrown into the motor coils successively, increasing gradually the number of ampère turns and possibly overcoming the difficulty and strain experienced in starting a heavily loaded car from a state of rest, and lessening the number of burnt-out armatures. By the use of such a mechanism no resistances are necessary, but the increments of current are supplied successively by a simple mechanical arrangement.

To resolve the mechanism above described into an electrical switch I simply make one mechanical change, and that is, to transform the motion of translation of the metallic piece A, Fig. 1, and C, Fig. 2, to a motion of rotation about an axis, and the following description of the switch will be sufficient explanation:

A cylinder of insulating material having a metallic axis is first made. A thin flat metal strip shaped like A, Fig. 1, or C, Fig. 2, is then cut out and wrapped around the cylinder, the sides V W and X Y of A, and the point V and the side X Y of C, coinciding with the two opposite circular edges of the cylinder, thus forming a helical plate. The plate is secured to the cylinder by metallic screws which project through to a good contact with the axis. The latter revolves in a metal bed or bushing and is held firmly by caps. The whole arrangement is set in a box of peculiar construction, as shown in Fig. 4. The metallic springs are attached to the bottom of the box, and press

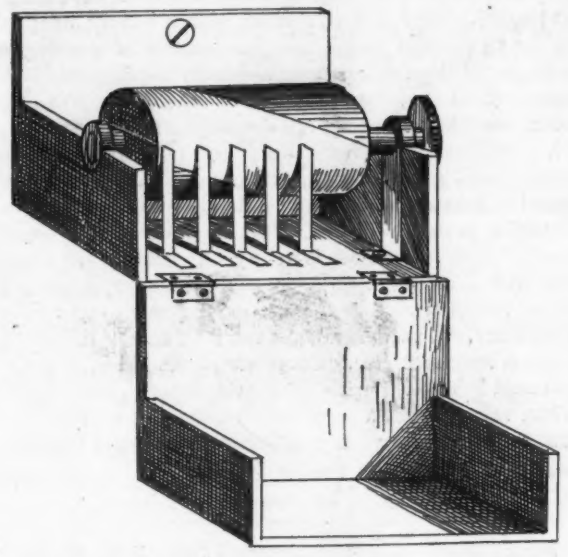


FIG. 4.—RODMAN'S COMBINATION SWITCH.

firmly against the cylinder. On the under side of the box are binding posts, one to each metallic spring. The terminal of the dynamo is led in through the bottom of the box and screwed to the metallic strip shown on the right side of the box. This strip is maintained in metallic connection with the helical plate on the surface of the cylinder by means of the metallic bushing, axis, and screws connecting the helical plate with the metallic axis. The screw seen at the top of the box is intended to fasten the whole arrangement to the wall. It will be seen that the box can be readily closed and opened without removing it from the wall; also that by taking off the caps over the axis of the cylinder the latter may be removed and the switch thereby rendered inoperative, so that the connection of the wires will not be attended with any danger. I think, at least, it can be claimed that the whole apparatus is very simple for one which combines so many different functions in so small a space.

The Electric Light and Power Company's Plant at Connellsville, Pa.

The Connellsville (Pa.) Electric Light and Power Company has had its central station in operation about six months. The work of installation was done by the North American Construction Company, of Pittsburgh. The officers of the company are as follows: President, J. D. Frisbee; secretary and superintendent, John L. Gans; treasurer, Eugene Norton; directors, Chas. Davidson, J. D. Frisbee, Dr. Phillips, and J. S. McCaleb.

The power house is one of the most commodious and best equipped in that part of the State. The part containing the dynamo room and offices measures 35 × 70 feet, and the boiler room attached is 20 × 35 feet. Steam is furnished by three tubular boilers, each 14 feet in length and 54 inches in diameter, with 64 3-inch tubes. These boilers give a total of 255 h. p. Three No. 6 "Park" injectors supply the boilers with pure soft water through a large tubular heater.

In the dynamo room are two Westinghouse compound automatic engines of 80 h. p. each and one "Junior" automatic of 50 h. p. The engines are belted direct to the dynamos. W. A. Bishop is chief engineer. Chas. Schieren's "electric" belting is used on all dynamos with the exception of two small direct current exciters.

The dynamos consist of two 750-light Westinghouse alternating incandescent machines with separate exciters, and one 60-light Westinghouse alternating arc machine. The board upon which instruments and switches are mounted is a model one and is supplied with very late patterns of Westinghouse instruments, such as rheostats, volt-meters, ammeters, compensators, station converters, line testers, ground indicator, fusible cut-out lightning arresters, switches, etc. One of the rooms partitioned off from the dynamo room is used chiefly for storing tools and outside line supplies for immediate use in case of accident to any part of the system. The small room adjoining is used as a repair room.

The incandescent machines are at present supplying current for an equivalent of some 1,500 lamps of 16 c. p. each, those in use being 10, 16, 25, 32, 50 and 100 c. p. lamps, and we are informed that the company has contracts for wiring that will run up the total to an equivalent of 1,800 or 2,000 lamps of 16 c. p. each.

The alternating arc machine supplies current for 44 arc and 20 series incandescent lamps which are furnished the borough authorities for street lighting, and also for seven commercial arc lamps. The street lamps are supported generally by Brady mast arms.

Electric Lighting at the Imperial Hotel.

The striking effect of elaborate interior decorations in modern buildings is often entirely due to the intelligent manipulation of the lighting arrangements. The readiness with which the incandescent light lends itself to the production of a great variety of desirable effects in the illumination of handsomely decorated interiors has made it possible to secure better results than could be obtained with other methods of lighting. In large and important buildings of modern construction the electric light is chosen not only as the safest method of illumination but as the one best adapted to harmonize with and enhance the effect of architectural designs and decorations.

A few weeks ago we were able to show the interior lighting arrangements of the Progress Club of this city, and, as exhibiting a similar use of the electric light, we are able this week to present to our readers, in the illustrations on the opposite page, some of the results which have been produced by the use of electric illumination in the Imperial Hotel, a very large building of modern construction which has just been completed in this city. The isolated plant which supplies current for this installation is very complete in every respect, and the building has been equipped more with regard to the ultimate safety, beauty and usefulness thus secured than with any thought of the total cost of the installation.

In the dynamo room are two United States dynamos of a capacity for 850 incandescent lights each. These are driven by two 75 h. p. Westinghouse engines belted direct from engine to dynamo pulley with the best quality of Schieren's perforated belts. The entire installation of the electric light plant was done by the United States Electric Light Company, of New York City. The switchboard is of marble, measuring 7 × 6 feet, and upon it are mounted 18 Westinghouse switches, two ammeters and one potential indicator. Two feeder circuits are run to and up the elevator shaft in wood moldings. At each floor branches are led off to supply the necessary number of lights. These branches are run in double interior conduits through the halls of each floor and single conduits are used to the outlets in the various rooms.

On the first or main floor are the corridors, offices, restaurant, café, bar room and reading room. The side walls of the corridor are composed of columns and panels of the finest Nubian marble. The restaurant is finished in Mexican onyx, after the style of the Marie Antoinette apartments in the Tuilleries. The ceilings in the corridors are modeled after those of the Vatican at Rome, the emblems having a special religious significance being omitted. The incandescent lamps are set into raised floral designs, and

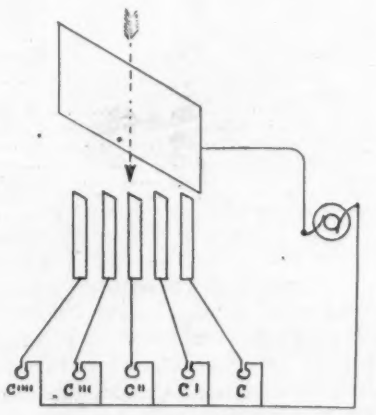
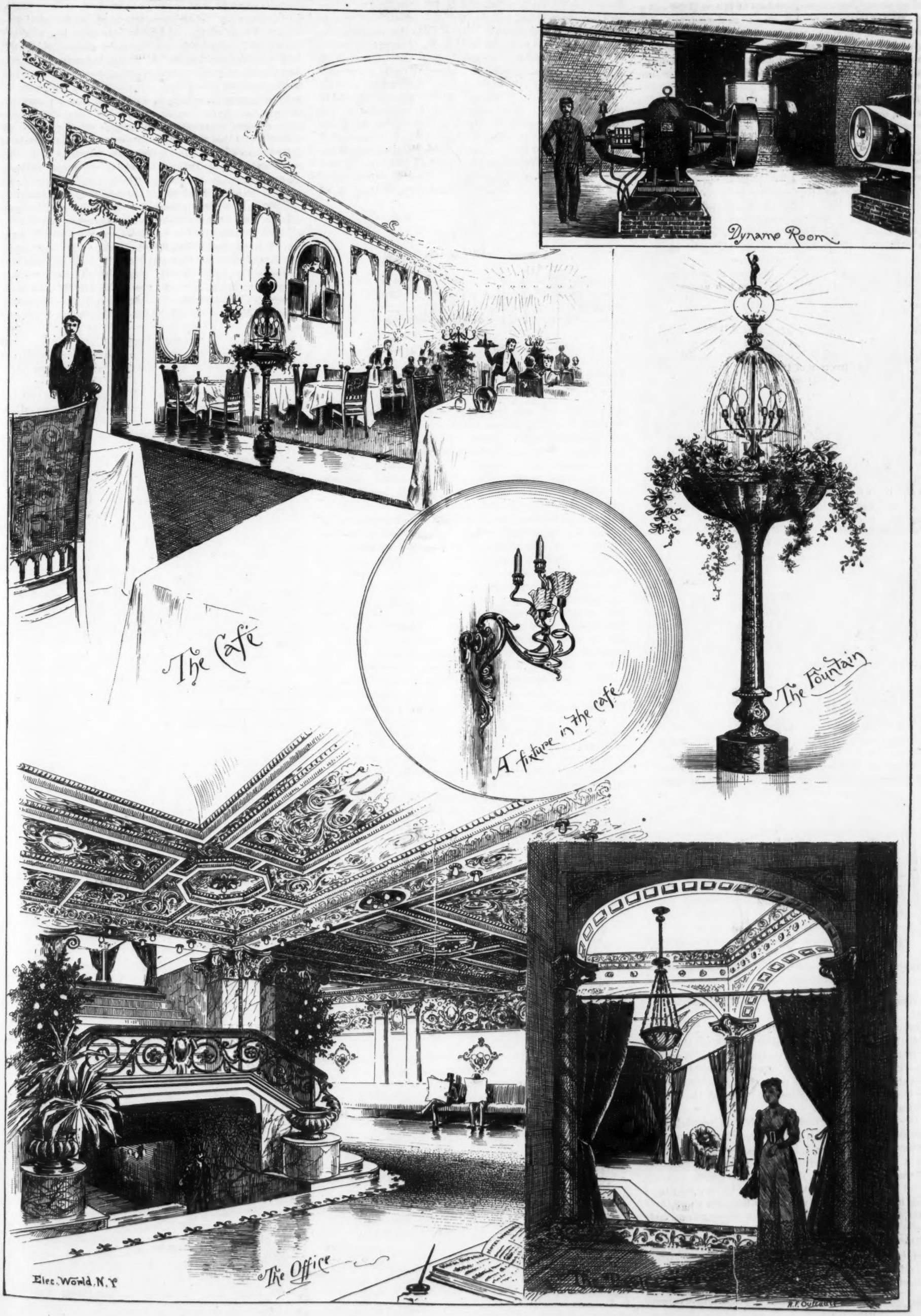


FIG. 3.—RODMAN'S COMBINATION SWITCH.

the effect produced upon the surrounding decorations is one of great brilliance.

The main halls upon the nine floors of the hotel above the corridor are furnished with elegant combination electroliers and each of the guest rooms contains very pretty combination fixtures and brackets, designed to harmonize with the oak finish used throughout these apartments. Each hall contains two independent circuits which are controlled by a switch placed in a convenient and suitable location. The main floor, however, has 14 independent circuits which are controlled from the switchboard so that any desired effect may be produced by the lighting of any number of lamps that may be necessary. Grimshaw white core wire is used throughout the building.

The hotel is also fitted with the most improved systems of electric bells, annunciators, burglar alarms, etc. In the office is a complete Herzog teleseme or guests' call system. An indicator in each guest room permits the guest to call for almost anything desired, and the signal is returned that the call has been received at the office. A burglar alarm attachment is placed on each door which connects through the call in each room with the main indicator in the office. The wiring for this call system was done by the Western Electric Company of New York.



ELECTRICAL ORNAMENTATION AT THE IMPERIAL HOTEL, NEW YORK CITY.

The Electromagnet.*

BY PROF. SILVANUS P. THOMPSON, D. SC., B. A., M. I. E. E.

(USES IN GENERAL.—CONTINUED.)

In Fig. 16 are plotted out the values of **H** and **B** for seven rings. One of these, marked *J*, was of cast steel, and was examined both when soft and afterwards when hardened. Another, marked *I*, was of the best Lowmoor iron. Five were of Crown iron, of different sizes. They were marked for distinction with the letters *G*, *E*, *F*, *H*, *K*. In the accompanying table are set down the values of **B** at different stages of the magnetization.

TABLE OF VALUES OF **B** IN FIVE CROWN IRON RINGS.

Name.	G.	E.	F.	H.	K.
Mean Diam.	21.5 cm.	10.035 cm.	22.1 cm.	10.735 cm.	22.725 cm.
Bar thickness.	2.535	1.298	1.292	0.7137	0.7544
Magnetizing Force.					
0.2	126	73	62	82	85
0.5	377	270	224	208	214
1	1,449	1,293	840	675	885
2	4,564	3,952	3,533	2,777	2,417
5	9,900	9,147	8,293	8.479	8,884
10	13,025	13,357	12.540	11,376	11,388
20	14,911	14 653	14,710	14,066	13,273
50	16,217	15,704	16,062	15,174	13,890
100	17,148	16,677	17,900	16,134	14,837

I have the means here of illustrating the induction method of measuring permeability. Here is an iron ring, having a cross section of almost exactly one square centimetre. It is wound with an exciting coil supplied with current by two accumulator cells; over it is also wound an exploring coil of 100 turns connected in circuit (as in Rowland's arrangement) with a ballistic galvanometer which reflects a spot of light upon yonder screen. In the circuit of the galvanometer is also included a reversing earth coil. As a matter of fact this earth coil is of such a size, and wound with so many convolutions of wire, that when it is turned over the amount of cutting of magnetic lines is equal to 840,000, or is the same as if 840,000 magnetic lines had been cut once. By adjusting the resistance of the galvanometer circuit, it is arranged that the first swing due to the induced current when I suddenly turn over the earth coil is 8.4 scale divisions. Then, seeing that our exploring coil has 100 turns, it follows that when in our subsequent experiment with the ring we get an induced current from it, each division of the scale over which the spot swings will mean 1,000 lines in the iron. I turn on my exciting current. See: It swings about 11 divisions. On breaking the circuit it swings nearly 11 divisions the other way. That means that the magnetizing force carries the magnetization of the iron up to 11,000 lines; or, as the cross-section is about 1 square centimetre, **B** = 11,000. Now, how much is **H**? The exciting coil has 180 windings, and the exciting current through the ampèremeter is just 1 ampère. The total excitation is just 180 "ampère-turns." We must, according to our rule given above, multiply this by 1.2566 and divide by the mean circumferential length of the coil, which is about 32 centimetres. This makes **H** = 7. So if **B** = 11,000 and **H** = 7, the permeability (which is the ratio of them) is about 1,570.

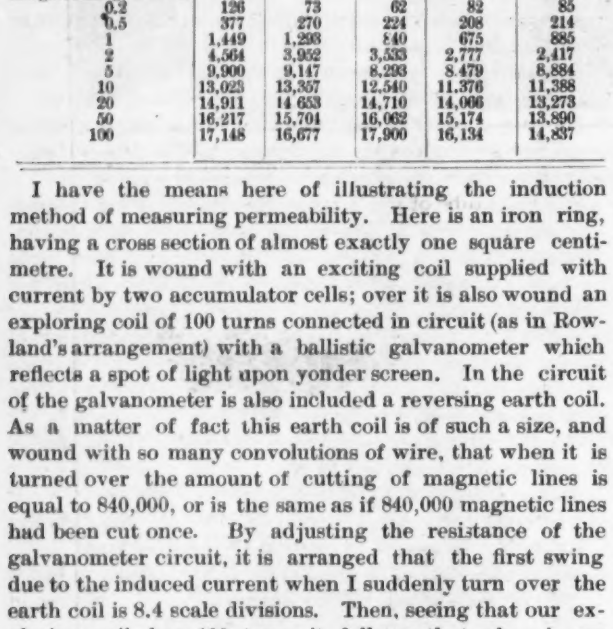


FIG. 16.—BOSANQUET'S DATA OF MAGNETIC PROPERTIES OF IRON AND STEEL RINGS.

It is a rough and hasty experiment, but it illustrates the method.

Bosanquet's experiments settled the debated question whether the outer layers of an iron core shield the inner layers from the influence of magnetizing forces. Were this the case, the rings made from thin bar iron should exhibit higher values of *B* than do the thicker rings. This is not so; for the thickest ring, *G*, shows throughout the highest magnetizations.

(*B*) *Bar Method.*—This method consists in employing a long bar of iron instead of a ring. It is covered from end to end with the exciting coil, but the exploring coil consists of but a few turns of wire situated just over the middle part of the bar. Rowland, Bosanquet and Ewing have all employed this variety of method; and Ewing specially used bars, the length of which was more than 100 times their diameter, in order to get rid of errors arising from end-effects.

(*C*) *Divided Bar Method.*—This method, due to Dr. Hopkinson†, is illustrated by Fig. 17.

The apparatus consists of a block of annealed wrought iron about 18 inches long, 6½ wide and 2 deep, out of the middle of which is cut a rectangular space to receive the magnetizing coils.

The test samples of iron consist of two rods, each 12.65 millimetres in diameter, turned carefully true, and slide in through holes bored in the ends of the iron blocks. These two rods meet in the middle, their ends being faced true so as to make a good contact. One of them is secured firmly, and the other has a handle fixed to it, by means of which it can be withdrawn. The two large magnetizing coils do not meet, a space being left between them. Into this space is introduced the little exploring coil, wound upon an ivory bobbin, through the eye of which passes the end of the movable rod. The exploring coil is connected to the ballistic galvanometer, *B G*, and is attached to an india-rubber spring (not shown in the figure), which, when the rod is suddenly pulled back, causes it to leap entirely out of the magnetic field. The exploring coil had 350 turns of fine wire; the two magnetizing coils had 2,008 effective turns. The magnetizing current, generated by a battery, *B*, of

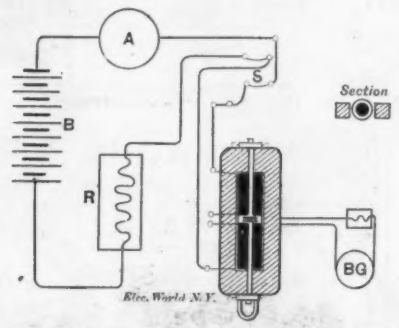


FIG. 17.—HOPKINSON'S DIVIDED BAR METHOD OF MEASURING MAGNETIC PERMEABILITY.

eight Grove cells, was regulated by a variable liquid resistance, *R*, and by a shunt resistance. A reversing switch and an ampèremeter, *A*, were included in the magnetizing circuit. By means of this apparatus the sample rods to be experimented upon could be submitted to any magnetizing forces, small or large, and the actual magnetic condition could be examined at any time by breaking the circuit and simultaneously withdrawing the movable rod. This apparatus, therefore, permitted the observation separately of a series of increasing (or decreasing) magnetizations without any intermediate reversals of the entire current. Thirty-five samples of various irons of known chemical composition were examined by Hopkinson, the two most important for present purposes being an annealed wrought iron and a gray cast iron, such as are used by Messrs. Mather and Platt in the construction of dynamo machines. Hopkinson embodied his results in curves, from which it is possible to construct, for purposes of reference, numerical tables of sufficient accuracy to serve for future calculations. The curves of these two samples of iron are reproduced in Fig. 18 but with one simple modification. British engineers, who unfortunately are condemned by local circumstances to use inch measures instead of the international metric system, prefer to have the magnetic facts also stated in terms of square inch units instead of square centimetre units. This change has been made in Fig. 18, and the symbols $\mathbf{B}_{''}$ and $\mathbf{H}_{''}$ are chosen to indicate the numbers of magnetic lines to the square inch in iron and in air respectively. The permeability or multiplying power of the iron is the same, of course, in either measure. In Table II. are given the corresponding data in square inch measure, and in Table III. the data in square centimetre measure for the same specimens of iron.

TABLE II. (Square Inch Units.)

Annealed Wrought Iron.			Gray Cast Iron.		
$\mathbf{B}_{''}$	μ	$\mathbf{H}_{''}$	$\mathbf{B}_{''}$	μ	$\mathbf{H}_{''}$
30,000	4,650	6.5	25,000	763	32.7
40,000	3,877	10.3	30,000	756	39.7
50,000	3,031	16.5	40.000	258	155
60,000	2,159	27.8	50,000	114	439
70,000	1,921	36.4	60,000	74	807
80,000	1,409	56.8	70,000	40	1,480
90,000	907	99.2	.....	.....	.....
100,000	408	245	.....	.....	.....
110,000	166	664	.....	.....	.....
120.000	76	1,581	.....	.....	.....
130.000	35	3,714	.....	.....	.....
140,000	27	5,185	.....	.....	.....

TABLE III. (Square Centimetre Units.)

Annealed Wrought Iron.			Gray Cast Iron.		
B	μ	**H**	**B**	μ	**H**
5,000	3,000	1.66	4,000	800	5
9,000	2.250	4	5,000	500	10
10,000	2,000	5	6,000	279	21.5
11,000	1,692	6.5	7,000	133	42
12,000	1,412	8.5	8,000	100	80
13,000	1,083	12	9.000	71	127
14,000	823	17	10,000	53	188
15,000	526	28.5	11,000	37	292
16,000	320	50	.....	.....	.....
17,000	161	105	.....	.....	.....
18,000	90	200	.....	.....	.....
19,000	54	350	.....	.....	.....
20,000	30	666	.....	.....	.....

It will be noted that Hopkinson's curves are double, there being one curve for the ascending magnetizations and a separate one, a little above the former, for descending magnetizations. This is a point of a little importance in designing electromagnets. Iron, and particularly hard sorts of iron, and steel, after having been subjected to a high degree of magnetizing force, are subsequently to a lesser magnetizing force found to retain a higher degree of magnetization than if the lower magnetizing force had been simply applied. For example, reference to Fig. 18 shows that the wrought iron, where subjected to a magnetizing force gradually rising from zero to $\mathbf{H}_{''} = 200$, exhibits a magnetization of $\mathbf{B}_{''} = 95{,}000$; but after $\mathbf{H}_{''}$ has been carried up to over 1,000, and then reduced again to 200, $\mathbf{B}_{''}$ does not come down again to 95,000, but only to 98,000. Any sample of iron which showed great retentive qualities, or in which the descending curve differs widely from the ascending curve, would be unsuitable for constructing electromagnets, for it is important that there should be as little residual magnetism as possible in the cores. It will be noted that the curves for cast iron show more of this residual effect than do those for wrought iron. The numerical data in Tables II. and III. are means between the ascending and descending values.

As an example of the use of the tables we may take the following: How strong must the magnetizing force be in order to produce in wrought iron a magnetization of 110,000 lines to the square inch? Reference to Table II., or to Fig. 18, shows that a magnetizing field of 664 will be required, and that at this stage of the magnetization the permeability of the iron is only 166. As there are 6.45 square centimetres to the square inch, 110,000 lines to the square inch corresponds very nearly to 17,000 lines to the square centimetre, and $\mathbf{H}_{''} = 664$ corresponds very nearly to **H** = 100.

TRACTION METHODS.

Another group of methods of measuring permeability is based upon the law of magnetic traction. Of these there are several varieties.

(*D*) *Divided Ring Method.*—Mr. Shelford Bidwell has kindly lent me the apparatus with which he carried out this method. It consists of a ring of very soft charcoal iron rod 6.4 millimetres in thickness, the external diameter being 8 centimetres, sawn into two half rings, and then each half carefully wound over with an exciting coil of insulated copper wire of 1,929 convolutions in total. The two halves fit neatly together; and in this position it constitutes practically a continuous ring. When an exciting current is passed round the coils both halves become magnetized and attract one another. The force required to pull them asunder is then measured. According to the law of traction, which will occupy us in the second lecture, the tractive force (over a given area of contact) is proportional to the square of the number of magnetic lines that pass from one surface to the other through the contact joint. Hence the force of traction may be used to determine **B**: and on calculating **H** as before we can determine the permeability. The following Table IV. gives a summary of Mr. Bidwell's results.

TABLE IV. (Square Centimetre Measure)
Soft Charcoal Iron.

B	μ	**H**
7,390	1899.1	3.9
11,550	1121.4	10.3
15,460	386.4	40
17,330	150 7	115
18,470	88.8	208
19,330	45.3	427
19,820	33.9	585

(*E*) *Divided Rod Method.*—In this method, also used by Mr. Bidwell, an iron rod hooked at both ends was divided across the middle, and placed within a vertical surrounding magnetizing coil. One hook was hung up to an overhead support; to the lower hook was hung a scale pan. Currents of gradually increasing strength were sent around the magnetizing coil from a battery of cells, and note was taken of the greatest weight which could in each case be placed in the scale pan without tearing asunder the ends of the rods.

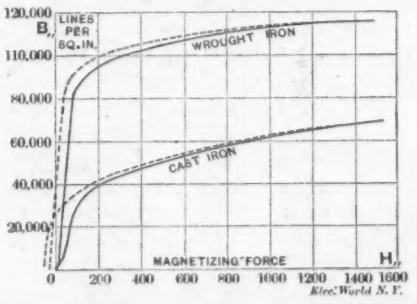


FIG. 18.—CURVES OF MAGNETIZATION OF IRON.

(*F*) *Permeameter Method.*—This is a method which I have myself devised for the purpose of testing specimens of iron. It is essentially a workshop method, as distinguished from a laboratory method. It requires no ballistic galvanometer, and the iron does not need to be forged into a ring or wound with a coil. For carrying it out a simple instrument is needed, which I venture to denominate as a *permeameter*. Outwardly, it has a general resemblance to Dr. Hopkinson's apparatus, and consists, as you see (Fig. 19), of a rectangular piece of soft wrought iron, slotted out to receive a magnetizing coil, down the axis of which passes a brass tube. The block is 12 inches long, 6½ inches wide, and 3 inches in thickness. At one end the block is bored to receive the sample of iron that is to be tested. This consists simply of a thin

* Cantor Lecture, No. 1, concluded from THE ELECTRICAL WORLD, Sept. 27, 1890.
† "Phil. Trans.," 1885, p. 456.

rod about a foot long, one end of which must be carefully surfaced up. When it is placed inside the magnetizing coil, and the exciting current is turned on, the rod sticks tightly at its lower end to the surface of the iron block; and the force required to detach it (or, rather, the square root of that force) is a measure of the permeation of the magnetic lines through its end face. In the first permeameter which I constructed the magnetizing coil is 13.64 centimetres in length, and has 371 turns of wire. One ampère of exciting current consequently produces a magnetizing force of $\mathbf{H} = 34$. The wire is thick enough to carry 30 ampères, so that it is easy to reach a magnetizing force of 1,000. The current I now turn on is 25 ampères. The two rods here are of "charcoal iron" and "best iron" respectively; they are of quarter-inch square stuff. Here is a spring balance graduated carefully, and provided with an automatic catch so that its index stops at the highest reading. The tractive force of the charcoal iron is about 12¼ pounds, while that of the "best" iron is only 7¼ pounds. $\mathbf{B}$ is about 19,000 in the charcoal iron, and $\mathbf{H}$ being 850, μ is about 22.3. The law of traction which I use in calculating $\mathbf{B}$ will occupy us much in the next lecture; but meantime I content myself in stating it here for use with the permeameter. The formula for calculating $\mathbf{B}$ when the core is thus detached by a pull of P pounds, the area of contact being A square inches, is as follows:

$$\mathbf{B} = 1{,}317 \times \sqrt{P \div A} + \mathbf{H}.$$

I may add that the instrument, in its final form, was manufactured from my designs by Messrs. Nalder Bros., the well-known makers of so many electrical instruments.

CURVES OF MAGNETIZATION AND PERMEABILITY.

In reviewing the results obtained, it will be noted that the curves of magnetization all possess the same general features, all tending toward a practical maximum, which, however, is different for different materials. Joule expressed the opinion that "no force of current could give an attraction equal to 200 pounds per square inch," the greatest he actually attained being only 175 pounds per square inch. Rowland was of opinion that the limit was about 177 pounds per square inch for an ordinary good quality of iron, even with infinitely great exciting power. This would correspond roughly to a limiting value of $\mathbf{B}$ of about 17,500 lines to the square centimetre. This value has, however, been often surpassed. Bidwell obtained 19,820, or possibly a trifle more, as in Bidwell's calculation the value of $\mathbf{H}$ has been needlessly discounted. Hopkinson gives 18,250 for wrought iron and 19,840 for mild Whitworth steel. Kapp gives 16,740 for wrought iron, 20,460 for charcoal iron in sheet, and 23,250 for charcoal iron in wire. Bosanquet found the highest value in the middle bit of a long bar to run up in one specimen to 21,428, in another to 29,388, in a third to 27,688. Ewing, working with extraordinary magnetic power, forced up the value of $\mathbf{B}$ in Lowmoor iron to 31,560 (when μ came down to 3), and subsequently to 45,350. This last figure corresponds to a traction exceeding 1,000 pounds to the square inch.

Cast iron falls far below these figures. Hopkinson, using a magnetizing force of 240, found the values of $\mathbf{B}$ to be 10,783 in gray cast iron, 12,408 in malleable cast iron, and 10,546 in mottled cast iron. Ewing, with a magnetizing force nearly fifty times as great, forced up the value of $\mathbf{B}$ in cast iron to 31,760. Mitis metal, which is a sort of cast wrought iron, being a wrought iron rendered fluid by addition of a small percentage of aluminum, is, as I have found, more magnetizable than cast iron, and not far inferior to wrought iron. It should form an excellent material for the cores of electromagnets for many purposes where a cheap manufacture is wanted.

A very useful alternative mode of studying the results obtained by experiment is to construct curves, such as those of Fig. 20, in which the values of the permeability are plotted out vertically in correspondence with the values of $\mathbf{B}$ plotted horizontally. It will be noticed that in the case of Hopkinson's specimen of annealed wrought iron, between the points where $\mathbf{B} = 7{,}000$ and $\mathbf{B} = 16{,}000$, the mean values of μ lie almost on a straight line, and might be approximately calculated from the equation:

$$\mu = (17{,}000 - \mathbf{B}) \div 3.5.$$

HYSTERESIS.

I have already drawn attention to the difference between the ascending and descending curves of magnetization, and may now point out that this is a part of a set of general phenomena of residual effects. The best known of these effects is, of course, the existence in some kinds of iron, and notably in steel, of a remanent or sub-permanent magnetization after the magnetizing force has been entirely removed. To this retardation of effects behind the causes that produce them the name of "hysteresis" has been given by Professor Ewing. If a piece of iron is subjected to a magnetizing force which increases to a maximum, then is decreased down to zero, then reversed and carried to a negative maximum, then decreased again to zero, and so carried round an entire cycle of magnetic operations, it is observed that the curves of magnetization form a closed area similar in general to those shown in Fig. 21. This closed area represents the work which has been wasted or dissipated in subjecting the iron to these alternate magnetizing forces. In very soft iron, where the ascending and descending curves are close together, the enclosed area is small, and as a matter of fact very little energy is dissipated in a cycle of magnetic operations. On the other hand, with hard iron, and particularly with steel, there is a great width between the curves, and there is a great waste of energy. Hysteresis may be regarded as a sort of internal or molecular magnetic friction, by reason of which alternate magnetizations cause the iron to grow hot. Hence the importance of understanding this curious effect, in view of the construction of electromagnets that are to be

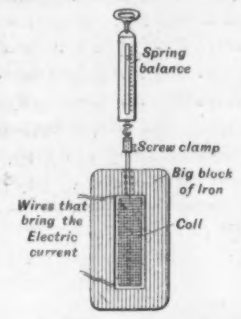


FIG. 19.—THE PERMEAMETER.

used with rapidly alternating currents. The following figures of Table V. give the number of watts (1 watt = $\frac{1}{746}$ of a horse power) wasted by hysteresis in well-laminated soft wrought iron when subjected to a succession of rapid cycles of magnetization.

TABLE V.—WASTE OF POWER BY HYSTERESIS.

B	B″	Watts wasted per cubic foot at 10 cycles per second.	Watts wasted per cubic foot at 100 cycles per second.
4,000	25,800	40	400
5,000	32,250	57.5	575
6,000	38,700	75	750
7,000	45,150	92.5	925
8,000	51,600	111	1,110
10,000	64,500	150	1,560
12,000	77,400	206	2,060
14,000	90,300	262	2,620
16,000	103,200	324	3,240
17,000	109,650	394	3,940
18,000	116,100	487	4,870

It will be noted that the waste of energy increases as the magnetization is pushed higher and higher in a disproportionate degree, the waste when $\mathbf{B}$ is 18,000 being six times that when $\mathbf{B}$ is 6,000. In the case of hard iron or of steel the heat waste would be far greater.

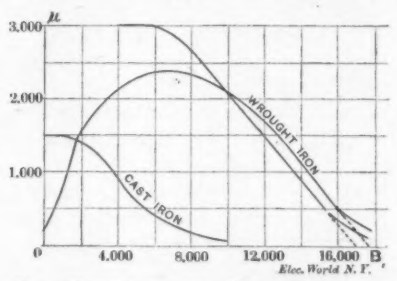


FIG. 20.—CURVES OF PERMEABILITY.

Another kind of after-effect was discovered by Ewing, and named by him "viscous hysteresis." This is the name given to the gradual creeping up of the magnetization when a magnetic force is applied with absolute steadiness to a piece of iron. This gradual creeping up may go on for half an hour or more, and amount to several per cent. of the total magnetization.

Another important matter is that all such actions as hammering, rolling, twisting and the like, impair the magnetic quality of annealed soft iron. Annealed wrought-iron which has never been touched by a tool shows hardly any trace of residual magnetization, even after the application of magnetic forces. But the touch of the file will at once spoil it. Sturgeon pointed out the great importance of this point. In the specification for tenders for instruments for the British Postal Telegraphs, it is laid down as a condition to be observed by the constructor, that the cores must not be filed after being annealed. The continual hammering of the armature of an electro-magnet against the poles may in time produce a similar effect.

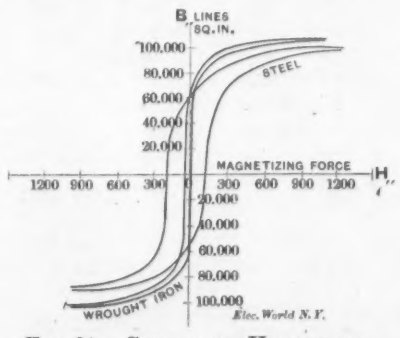


FIG. 21.—CURVES OF HYSTERESIS.

FALLACIES AND FACTS ABOUT ELECTROMAGNETS.

I will conclude this lecture by stating a few of the fallacies that are current about electromagnets, and will add to them a few facts, some of which seem paradoxical. The refutation of the fallacies and the explanation of the facts will come in due course.

Fallacies.—The attraction of an electromagnet for its armature varies inversely as the square of its distance from the poles.

The outer windings of an electromagnet are necessarily less effective than those that are close to the iron.

Hollow iron cores are as good as solid cores of the same size.

Pole pieces add to the lifting power of an electromagnet.

It hurts an electromagnet (or, for that matter, a steel magnet) to pull off the keeper suddenly. [It is the sudden slamming on that in reality hurts it.]

The resistance of the coil of an electromagnet ought to be equal to the resistance of the battery.

A coil wound left-handedly magnetizes a magnet differently from a coil wound right-handedly. [It is not a question of winding of coil but of circulation of current.]

Thick wire electromagnets are less powerful than thin wire electromagnets.

A badly insulated electromagnet is more powerful than one that is well insulated.

A square iron core is less powerful (as Dal Negro says, eighteen-fold!) than a round core of equal weight.

The attraction of an electromagnet for its keeper is necessarily less strong (one-third according to Du Moncel) sideways than when the keeper is in front of the poles.

Putting a tube of iron outside the coils of an electromagnet makes it attract a distant armature more powerfully.

Facts.—A bar electromagnet with a convex pole holds on tighter to a flat-ended armature than one with a flat pole does.

A thin round disc of iron laid upon the flat round end of an electromagnet (the pole end being slightly larger than the disc) the disc is not attracted, and will not stick on, even if laid down quite centrally.

If a flat armature of iron be presented to the poles of a horseshoe electromagnet the attraction at a short distance is greater, if the armature is presented flankways, than if it is presented edgeways. On the contrary, the tractive force in contact is greater edgeways than flankways.

Electromagnets with long limbs are practically no better than those with short limbs for sticking on to masses of iron.

Contributions to the Molecular Theory of Induced Magnetism.*

BY J. A. EWING, F. R. S.

As the facts of induced magnetism become better known, increasing interest attaches to molecular theories, and increasing difficulty attends the theories that are current. Weber's fundamental conception that the molecules of iron or nickel, or cobalt, are always magnets, and that the process of magnetizing consists in turning them from many directions toward one direction, has been strongly confirmed by the now well established fact that there is a true saturation value, a finite limit to the intensity of magnetism, which may be reached or very closely approached by using a strong magnetic force.† Without going further back to inquire (with Ampère) how the molecules come to be magnets, we may take this conception as the natural starting point of a theory. But when we go on to examine the conditions of constraint on the part of the rotatable molecules which have been suggested to make the theory square with what is known about permeability, about residual magnetism, and other effects of magnetic hysteresis, about the effects of stress, of temperature, of mechanical vibration, and so forth, we find a mass of arbitrary assumptions which still leave the subject bristling with difficulties. Many of the phenomena suggest, for instance, the idea that there is a quasi-frictional resistance which opposes the turning of the molecular magnets; this notion lends itself well to account for the most obvious effects of magnetic hysteresis and the reduction of hysteresis by vibration. On the other hand, it conflicts with the fact that even the feeblest magnetic force induces some magnetism. My object in this paper is to refer to another (and not at all arbitrary) condition of constraint which not only suffices to explain all the phenomena of hysteresis without any notion of friction, but seems to have in it abundant capability to account for every complexity of magnetic quality.

In describing Weber's theory, Maxwell points out that, if each molecular magnet were perfectly free to turn, the slightest magnetic force would suffice to bring the molecules into complete parallelism, and thus to produce magnetic saturation. He continues: "This, however, is not the case. The molecules do not turn with their axes parallel to the force, and this is either because each molecule is acted on by a force tending to preserve it in its original direction, or because an equivalent effect is produced by the mutual action of the entire system of molecules. Weber adopts the former of these suppositions as the simplest.‡ Weber supposes a directing force to act in the original direction of the molecule's axis, which continues to act as a restoring force in that direction after the molecule is disturbed. This assumed constraint is quite arbitrary; moreover, if it were the only constraint, there would be no residual magnetism when the deflecting force was withdrawn. Accordingly, Maxwell modifies Weber's theory by introducing the further assumption that when the angle of deflection exceeds a certain limit the molecule begins to take permanent set. The development of this, however, does not agree well with the facts. The alterna-

*Paper read before the Royal Society, June 19, 1890.
†Ewing and Low, *Phil. Trans.*, 1889, A, p. 221; see also H. E. J. G. du Bois, *Phil. Mag.*, April, 1890.
‡ Maxwell, "Electricity and Magnetism," Vol. II., § 443.

tive which is offered in the sentence I have quoted from Maxwell was not followed up by him, and seems to have been very generally overlooked, notwithstanding its obvious freedom from arbitrary assumption. Several writers, notably Wiedemann* and Hughes,† have recognized the inter-molecular magnetic forces by suggesting that the molecules, when unacted on by any magnetizing force from outside, may form closed rings or chains, "so as to satisfy their mutual attraction by the shortest path."‡ But Wiedemann expressly postulates a frictional resistance to rotation, which will prevent this arrangement from being more than approximately attained, and which may be more or less overcome by vibration.§

I lately commented on the fact that soft iron and other magnetic metals (notably nickel under particular conditions of strain ‖) show a remarkably close approach to instability at certain stages in the magnetizing or demagnetizing process.¶ When the magnetic force reaches a particular value, the rate of change of magnetism with respect to change of force may become enormous. Referring to this

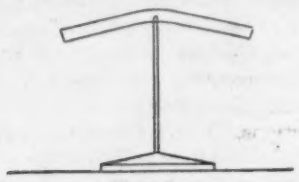


Fig. 1.

in a paper which has just been published;** Mr. A. E. Kennelly has reverted to the idea of chains of magnetic molecules, held together by the intermolecular magnetic forces, and contends that when such a chain is ruptured by applying a sufficiently strong external magnetic force it will fall to pieces throughout, and the molecular magnets which compose the same will take their alignment suddenly. He accordingly sketches what he calls a "chain-theory" of magnetization and an adaption of the theory of Hughes, in which, however, he postulates an elastic resistance to the rotation of the molecules in addition to the constraint afforded by their mutual magnetic forces. Mr. Kennelly's remarks are highly interesting and suggestive; but I do not think (for reasons which will appear immediately) that the notion of closed magnetic chains can be maintained as a general account of the molecular structure of unmagnetized iron.

I have experimented on the subject by making a model molecular structure consisting of a large number of short steel bar-magnets, strongly magnetized, each pivoted like a compass-needle upon a sharp vertical centre and balanced to swing horizontally. We cannot readily imitate in a model the two degrees of rotational freedom possessed by the axes of actual molecular magnets, but a group of magnets swinging in one plane gives a sufficiently good general idea of the nature of the equilibrium which is brought about by inter-molecular forces, and the manner in which that equilibrium is disturbed when an external force is applied. The model is very easily made. Each magnet is a piece of steel wire about one-tenth of an inch in diameter and two inches long (Fig. 1), bent in the middle to bring the centre of gravity below the point of support. The hole, or rather recess, for the pivot is made by a centre punch; the pivot itself is a sewing-needle fixed upright in a small base-plate which is punched out of a sheet of lead. The bars swing with but little friction, and their pole strength is sufficient to make the mutual forces quite mask the earth's directive force when they are set moderately near one another. The group is arranged on a board on which lines are drawn to facilitate regularity in grouping

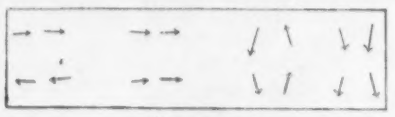


Fig. 1 a.

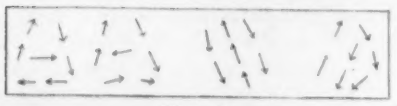


Fig. 2.

when that is wanted, and the board slips into a large frame or open-sided flat box wound round the top, bottom and two sides with a coil through which an unjustable current may be passed to expose the group to a nearly homogeneous external magnetic force. The coil is wound in a single very open layer, through which a sufficiently good view of the group inside is obtained. A liquid rheostat with a sliding terminal is used to secure continuity in varying the magnetic force. It is scarcely necessary to add that the magnetic force which is applied to the group is too weak to have any material effect on the magnetism of individual bars. It alters their alignment only, just as a magnetic force alters the alignment of Weber's molecular magnets.

When a number of these magnets are grouped either in a regular pattern or at random, and are left after disturbance to come to rest free from external magnetic force, they of course assume a form which has no resultant magnetic moment, provided the number be sufficiently great; but it is apparent that they do not arrange themselves in closed chains. And such configuration would in general be unstable. Many stable configurations admit of being formed, and if the magnets are again disturbed and left to settle the chances are much against any one configuration immediately repeating itself. One general characteristic of these configurations is that they contain lines consisting of two, three, or more magnets, each member of a line being strongly controlled by its next neighbors in that line, but little influenced by neighbors which lie off the line on either side. Thus, if there are two magnets simply, they form (as might be anticipated) a highly stable pair. With three magnets, two form a line along one side of the triangle joining the fixed centres, and the third lies parallel, or nearly so, facing oppositely. Four magnets will usually form two lines with directions which lie nearly along two sides of the quadrilateral; but diagonally opposite magnets may pair, leaving the others unattached. Suppose them set at the corners of a rectangle with unequal sides; they may lie in any of these forms (Fig. 1a), if the inequality in distance be not too great. All these configurations are stable, and the condition of least energy, while making the first of them the most probable, does not prevent the occasional formation of the others. In a long line, the same condition leads in general to the formation of a continuous section; but it is by no means uncommon to find a line broken into two or more sections. Seven magnets grouped so that the centres of six form a regular hexagon, with one in the middle, have a great variety of possible stable configurations, of which these are examples (Fig. 2).

Experimental study of the forms which may be assumed by groups, and of the vibrations which may be transmitted through groups, is interesting, but to pursue it would be beside my present purpose. In all cases, the configuration assumed by a group is such that there is stability for small displacements, but different positions of the group may be stable in different degrees, and if members of the group be turned through a sufficiently great angle, they become unstable and fall into a new position of stability, bringing about a partial reconstruction of the lines that characterize the group. Special interest attaches to square patterns from the fact that iron and nickel (probably cobalt also) crystallize in the cubic system. In a square pattern of many members we find, in general, lines running parallel with all sides of the square when the group settles without directive force after a disturbance.

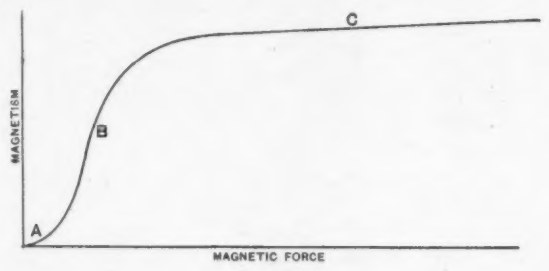


Fig. 3.

Let the group, or collection of groups, be subjected to an external magnetic force, **H**, gradually increasing from zero. The first effect is to produce a *stable* deflection of all members except those which lie exactly along or opposite to the direction of **H**. This results in giving a small resultant moment to the group (assuming that there was none to begin with), which increases at a uniform or very nearly uniform rate as **H** increases. This corresponds to the first stage in the magnetization of iron or other magnetic metal (*a*, Fig. 3). The initial susceptibility is a small finite quantity, and it is sensibly uniform for very small values of **H**.

Suppose that, without going beyond this stage we remove **H**; the molecular magnets, not having been deflected beyond the limit of stability, simply return to their initial places, and there is no residual magnetism. This, again, agrees with the fact that no residual magnetism is produced by very feeble magnetizing forces. Up to this point there has been no magnetic hysteresis. But let the value of **H** be increased until any part of the group becomes unstable, and hysteresis immediately comes into play. At the same time, there begins to be a marked augmentation of susceptibility—that is to say, a marked increase in the rate at which resultant moment is acquired. It is not difficult to arrange groups in which the state of instability is reached with one and the same value of **H** throughout the group. But, in general, we shall have different elementary magnets, or different lines of them, reaching instability with different values of **H**. The range of **H**, however, which suffices to bring about instability throughout the whole, or nearly the whole of the members in most groups, is not large; we, therefore, find in the action of the model a close analogy to the second stage (*b*, Fig. 3) of the process of magnetization, in which the magnetism rises more or less suddenly, as well as to the first stage (*a*).

During the second stage (*b*), the magnetic elements fall for the most part into lines which agree more or less exactly with the direction of **H**. If at the end of this stage we remove **H**, we find that a very large proportion of the moment which the group has acquired remains; in other words, there is a great deal of residual magnetism. To take an instance, suppose we have a group lying initially as in Fig. 4, and apply a magnetic force, **H**, in the direction sketched; the first stage (*a*) deflects all the molecular magnets slightly, without making any of them become unstable; the second stage (*b*) brings the molecules into the general direction shown in Fig. 5, or rather that is the direction they assume when **H** is removed, and the residual magnetism contributed by the group is then the sum of their moments resolved along **H**. When **H** is acting, the components along **H** are slightly greater, for the molecules are then (stably) deflected through a small angle toward the line of **H**.

Let **H** be further increased—we now have the third stage (*c*, Fig. 3), which consists in the closer approach to saturation that is caused by the molecules being more nearly pulled into exact line with **H** (Fig. 6). Whether there will be instability during the deflection of them from the lines of Fig. 5 will depend on the closeness of the poles and on the inclination of the lines of Fig. 5 to the direction of **H**. In some groups saturation will be complete with a finite value of **H**; in others it will only be closely approximated to. In magnetizing any actual specimen of iron we have, of course, to deal with a multitude of groups, the lines to which lie at very various inclinations to **H**. If we remove the force **H** at a point in stage *c*, we find very little, if any, more residual magnetism than was found at the end of stage *b*. The ratio of residual to induced magnetism is a maximum about the end of stage *b*, and diminishes as stage *c* proceeds. This, again, agrees completely with the observed facts.

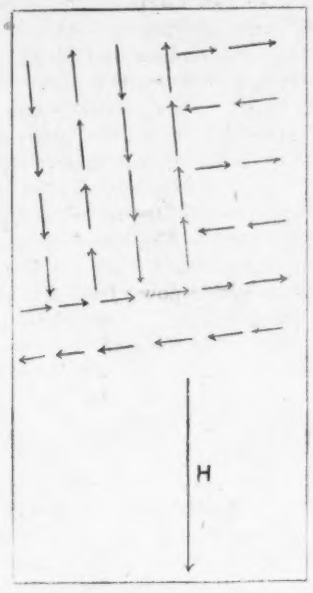
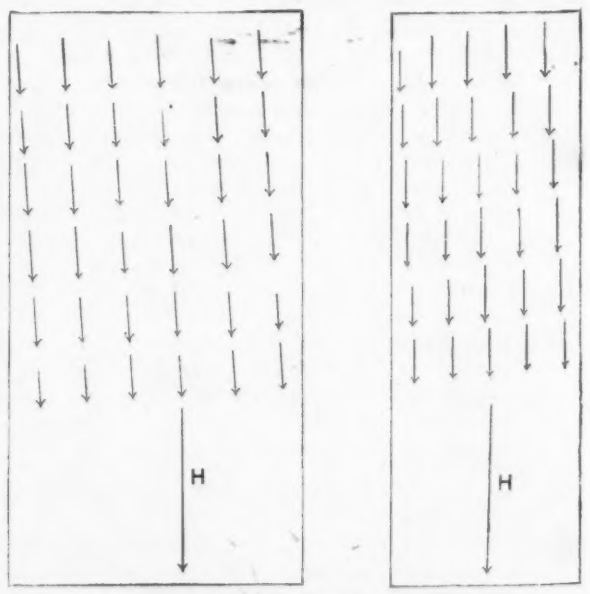


Fig. 4.

There is *some* hysteresis during the removal (whether complete or partial) and reapplication of magnetic force, because (provided we have enough groups to deal with) there will be some lines of elements which pass to and fro through a condition of instability during the removal and reapplication of the force. For certain inclinations of the line, the movements are not reversible.

Suppose, next, that having applied and removed a strong force **H**, leaving strong residual polarity, we begin slowly to reverse **H**. At first the effects are slight; presently, however, instability begins, and as the force is increased within a narrow range we find the molecules all upset. This is followed by a stage of nearly elastic deflection as saturation is approached. Thus the well-known general characteristics of cyclic processes are all reproduced in the model (see Fig. 8).



Figs. 5 and 6.

Again, a small repeated cyclic change of **H** superposed upon a constant value of **H** produces small changes of aggregate polarity, which are reversible if the change of **H** is very small. This, as Lord Rayleigh has shown,* is what happens in a magnetic metal, and the susceptibility with respect to small cyclic changes is small in the model, just as it is in the actual solid.

(To be continued.)

* Wiedemann, *Galvanismus*, Second Edition, Vol. II. (1), p. 373.
† Hughes, Roy. Soc. *Proc.*, May 10, 1883.
‡ Hughes, *loc. cit.*
§ Wiedemann, Phil. Mag., July, 1886, p. 52; *Elektricität*, Vol. III., §§ 781–785.
‖ See a Paper by H. Nagaoka, *Journal* of the Science College of the University of Tokio, Vol. II. (1888), p. 304.
¶ *Journal* of the Institution of Electrical Engineers, No. 84 (1890), pp. 38–40.
** *The Electrician* (London), June 7 and 13, 1890.

* *Phil. Mag.*, March, 1887.

The Lineff Electric Tramway.*

BY GISBERT KAPP, M. I. E. E.

Engineers and tramway managers, not less than the traveling public, are agreed as to the desirability of replacing animal by some sort of mechanical traction; and electrical engineers in particular are convinced that of all methods of applying mechanical power that involving the use of electromotors is the most convenient for the ordinary type of tram line. On lines with exceptionally steep gradients the cable has the advantage over the steam locomotive and electromotor that the weight of the car to be hauled up the grade is a minimum; but on lines which are not too steep to be worked by steam or horses this advantage is on long lines more than counterbalanced by the waste of power involved in keeping the cable itself in motion; and it is in these cases, which form the majority, that the electromotor has the most promising field of application. It may be asked how it comes that with all these circumstances in its favor, electric traction on tramways has made in this country so little progress. We have cheap coal, good steam engines, excellent dynamos and thoroughly reliable and efficient electromotors. The transmission of power from the motor spindle to the axle of the car, although not so easy a problem as it might perhaps appear at first sight, does not present any insuperable difficulties, and has, in fact, been very satisfactorily solved by more than one engineer. The application of electricity to traction should therefore be an easy matter. Yet progress is slow. The explanation appears to be that although the generation of the electric current taken by itself is easy enough, and the conversion of this current into mechanical power taken by itself is easy enough, the connecting link between the two processes, namely, the conveyance of the current from the dynamo at the tramway depot to the car on the line, is a matter of some difficulty, and as yet we have no system of conveyance which may be considered as satisfactory in every respect. It is in this direction that inventors should work. There is very little need for improved dynamos, motors, switches, or other gear; all these appliances, though not absolutely perfect, are quite good enough for practical work. There is, however, great need for improved methods of conveying the electric current to the car in a manner which shall at once be economical, certain, free from danger to persons and animals, offer no obstruction to the general traffic in the streets, and be acceptable on æsthetic grounds. All these conditions except the first are fulfilled in those systems where a storage battery is used for conveying the current from the dynamo at the depot to the motor on the car; but unfortunately the first condition is too important to be neglected, since the fundamental reason for substituting mechanical for horse traction is not a humanitarian or scientific one, but the aim to save a penny or two per car mile, and thus increase the financial prosperity of the company. I do not say that such a saving may not be effected by the use of battery cars; but I say that up to the present we have no practical proof that such cars are more economical to work than horse cars; and I maintain that whatever saving may result from the adoption of batteries, a greater saving under the same circumstances must result from direct working; that is, working under some system of conveying the current direct from the dynamo to the motor by means of a conductor. On the other hand, there may be reasons for preferring the storage car, notwithstanding its lower efficiency; but I do not propose to enter into this subject, as it can only be satisfactorily discussed with reference to the local conditions in each particular case. My object is to bring before you a new system of direct supply for tram cars, which has recently come under my notice, and which seems to fulfill all the conditions stated above.

When we have to convey current to the car by means of a conductor, this conductor must run along the line either above or below ground. In the former case it may be a wire suspended along poles, or a rail resting on insulating supports close to the ground, or it may be formed by the tram rails themselves. All these arrangements have been tried, but it is needless to say that they are inadmissible for urban and suburban lines in this country. With such lines the first condition must necessarily be to place the

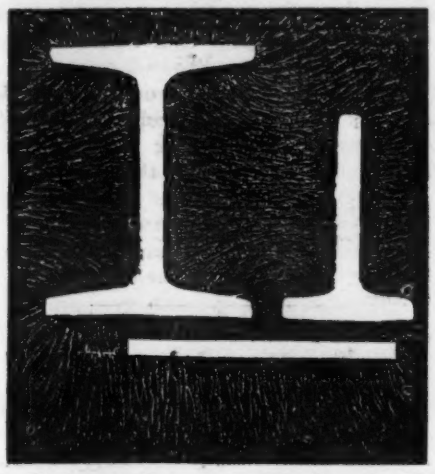
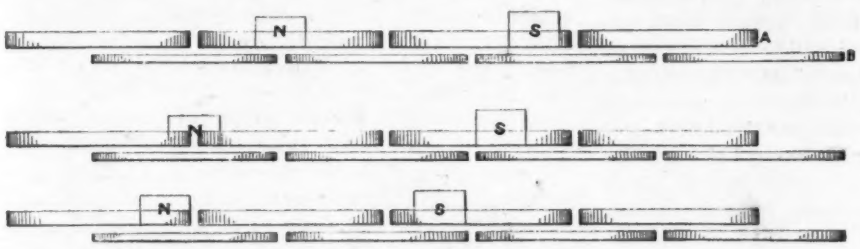


FIG. 1.—MAGNETIC CIRCUIT OF THE LINEFF SYSTEM.

conductor underground. As usually carried out this system involves the adoption of a slot in the road through which passes a slipper or contact-shoe attached to the car, and which establishes electrical connection between the conductor underground and the motor on the car. The system is, as experience shows, practically workable; though the slot, which must admit dirt and moisture into the underground channel and may to a certain extent inconvenience other traffic, is a disadvantage. This disadvantage may perhaps not be very great considered from a purely technical point of view, but such as it is it has to be taken into account. If we consider the question from the point of view which will naturally be taken by the local authorities and the public whom they represent, we shall come to the conclusion that the slot is a great disadvantage to the general traffic, and that its abolition is highly desirable. How to abolish the slot and yet retain electrical connection between the underground conductor and the motor on the car is the problem which has been solved in the system of electric tramway I am about to describe.

The conductor consists of bare copper strip or cable, and of iron strip. The latter is galvanized so as to protect it from rusting. It lies on the copper conductor, and both are inclosed in a sealed channel formed of asphalt. The copper conductor rests upon the bottom of a trough made of a succession of glazed tiles, and the cover to this trough is formed by the lower flanges of iron rails arranged in short sections so as to be insulated from each other. The head of one rail reaches up to the surface of the road; the head of the other is cut off, and this rail is, therefore, completely buried in the asphalt. The surface rail, which may be arranged alongside one of the ordinary tram rails, or in the centre of the track, is in electric and magnetic contact with an electromagnet carried under the car. This magnet runs upon the surface rail on wheels, which form its north and south poles. The distance of the wheels is greater than the length of a section of insulated rail, so that successive sections become oppositely magnetized. This causes the iron strip immediately below the magnetized region to be attracted upwards and thus come into contact for a length of several feet with the under side of the two sectional rails. At the same time the iron strip to both sides of this region remains in contact with the copper conductor, and forms thus an electrical connecting link between the copper conductor and a few sections of insulated rail under the car. The current passes from the sur ace rail through the body of the electromagnet (which is insulated from the body of the car) into the motor, and finally into the ordinary tram rails and earth in the usual manner. The electro-magnet is energized by a shunt current obtained from the main conductor, but to provide for the possibility of dropping the strip from some unforeseen cause there is placed on the electromagnet a third thick wire coil, which can at all times be energized by two storage cells carried on the car, and thus the strip can be picked up and the main circuit again established if it should have been accidentally interrupted. I may, however, at once state that during some tests which I made on an experimental line of this kind, and which lasted over several days, there has been no need for the picking-up battery, as the current was never lost. I shall say a few words about the results of these tests presently; but before entering upon the practical results I would draw your attention to a question of both practical and theoretical importance—namely, the way in which Mr. Lineff makes use of magnetic lines of force to effect the attraction of the iron strip. It might, perhaps, be thought that the most direct and therefore the best way of utilizing the lines of force would be by one single line of sectional rail through which there would be longitudinal magnetic flux corresponding with the fore and aft position of the poles and attraction of the strip at every gap between two sections. Experiment has, however, shown that this apparently direct way is by no means the best way, and that far more satisfactory results can be obtained by arranging a more roundabout course for the lines of force. This is attained by the employment of the subsidiary or buried rail, the gaps in which do not exactly correspond with those in the main or surface rail, but are shifted forward by a certain amount. In consequence of this arrangement, the buried rail acts as a kind of magnetic bridge to successive portions of the surface rail, and this action takes place in two ways, one direct and the other indirect. The direct way is longitudinal, and does not affect the strip at all. The indirect way is both longitudinal and transverse, the latter passing several times through the strip. The buried rail is a rather imperfect bridge to the lines of force traversing it longitudinally, because its magnetic resistance in that direction is great, but this rail forms a very efficient bridge for lines passing through it tranversely, owing to its lower magnetic resistance in that direction, which includes the strip. This flow of magnetic force tranversely is, therefore, that which effects the attraction of the strip, and may be represented as a series of magnetic stitches passing to and fro between the two sets of rails and the strip.



FIGS. 2, 3 AND 4.—MAGNETIC CONDITION OF THE RAILS.

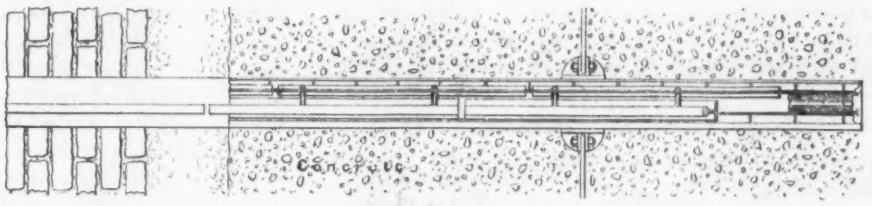


FIG. 5.—PLAN OF TRACK, LINEFF TRAMWAY SYSTEM.

This action will be understood by reference to the diagrams 2 to 4, which represent the magnetic condition of the rails for three positions of the electro-magnet. North polarity is indicated by *N*, and south polarity by *S*. *A* represents the surface rail, and *B* the buried rail. The energy provided to attract the strip is only 180 watts, or equivalent to that consumed by three glow lamps; and this I have found sufficient under all circumstances. Fig. 6 is a cross section, Fig. 5 a plan, and Fig. 7 a longitudinal section of the line and electro-magnet.

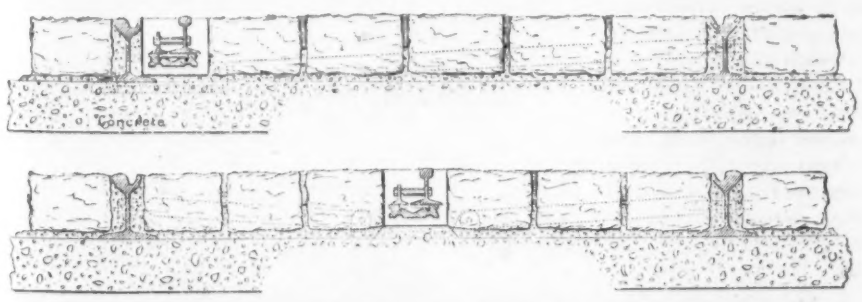


FIG. 6.—ARRANGEMENT OF MAGNETIC CONDUCTORS.

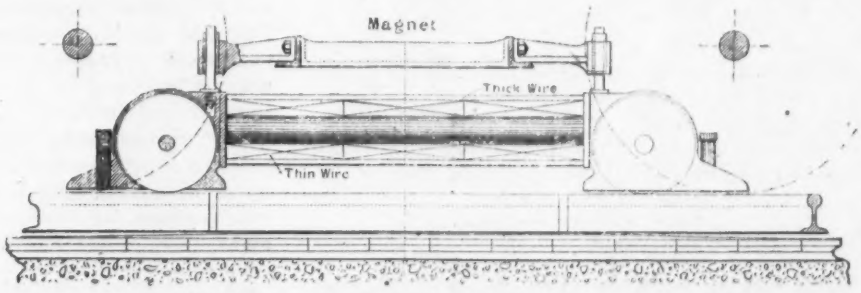


FIG. 7.—SECTION OF LINE AND ELECTRO-MAGNET.

The experiments to which I have referred were undertaken to see whether the whole system is practically workable. The first question which presented itself was whether the wave in the strip running along at the speed of the car was likely to induce subsidiary waves either in front or behind the car, whereby exposed sections of the surface rail might become charged and be a danger to ordinary traffic. To investigate this matter a pilot brush was fitted to the car at different distances from its centre, and connected with an electric bell. The pilot brush was so placed as to slide over the surface rail, and if on a charged section the bell would sound. It was found that the charged region was at all speeds considerably shorter than the length of an ordinary car. Contact tests were also made over the whole line at greater distances from the car than the pilot brush could reach, and in no case have I found an exposed section of rail charged. There was, further, the danger that with a dry and dirty line the collection of current might

* Paper read before the British Association in Section G, Leeds, September, 1890.

be accompanied by sparking, which would frighten horses: but this difficulty was overcome by fitting wire brushes to the pole-shoes of the electro-magnet.

An important point in all conductor systems of electric tramway is the energy spent in collecting the current. With the overhead wire system this is very small and practically inappreciable. With an underground system it is naturally larger. In the first system elaborated by Mr. Lineff, the flexible underground shoe with its trailing rope required from 20 to 48 pounds for its propulsion. In the series system the "arrow" rubbing through the "spring jacks" must necessarily also require the application of considerable force; but I have no figures on this point. In the new Lineff system the electro-magnet rolls on the surface rail and the propelling energy is consequently small. I am informed by Mr. Lineff that he has succeeded in reducing it to 210 watts with the magnet energized. The whole power spent in collection of current is therefore about half a horse-power.

The insulation resistance of the conductor was tested both by the bridge method (48 Leclanché cells, Post Office pattern bridge, and mirror galvanometer), and by passing the leakage current through a voltmeter, and the two methods gave fairly accordant results. The highest reading I recorded by the voltmeter test, when the full pressure of 230 volts was on the conductor, was 5,400 ohms, and the lowest 3,550 ohms. From these figures it appears that the average insulation is 186 ohms per mile.

To ascertain the surface leakage I also applied the voltmeter test, and found the following insulation resistances of three charged sections of magnetic rail. With the line clear and moist,* 4,183 ohms; with the line very wet and covered with mud and horse droppings, 980 ohms. Taking 2,000 ohms as an average, the loss of power at 300 volts by surface leakage per car amounts to 45 watts.

The mechanical strength of the line was tested by running a steam roller over it in various directions, under which treatment the line suffered no damage whatever.

On an Illustration of Contact Electricity Presented by the Multicellular Electrometer.*

BY SIR WILLIAM THOMSON.

Contact electricity of strong metals absolutely removed from possibility of chemical action is a subject which was formerly much discussed, but now the fact of that kind of action is thoroughly admitted, and most of the natural history of the subject is pretty well known. I have not to-day to add to the knowledge of the subject, but merely to remark that it brings out a very curious feature in electrostatic instruments, in illustrating its application to this instrument of contact electricity. The metals in question are brass and aluminum. I am sorry I cannot show you the interior of the instrument just now, but a sketch will probably make it understood. The instrument consists in a multicellular electrometer. In its working it is a number of cells, as the designation indicates, with a needle, or a number of needles, moving under the influence of these cells. There are 20 cells, one over the other, and we will represent this in section.

There are 10 cells acting on one set of ends and 10 at the other. The needles are mounted one above the other on a stem, which hangs by a fine platino-iridium wire. The principle is simply this—the needle is connected through its fine wire with the outside case of the instrument, which is one of the metals between which the difference of potential has to be measured. The other metal is the cells—this pile of cells and the other pile of cells are metallically connected. They are insulated from the outer case of the instrument, and we have a binding screw here connected metallically with the cells, and insulated from the case of the instrument we have another binding screw. The instrument is adapted to measure difference of potential between these two metals. It is analogous to the quadrant electrometer with its needles and quadrants used as two bodies, the needle connected with the case of the instrument. In the quadrant electrometer contact electricity was illustrated by making the two pairs of quadrants, say, of zinc and copper. I have noted a very different manifestation of contact electricity presented by this form of electrometer. Let us suppose that the needles and the cells are maintained at a difference of potential of, say, 100 volts, this instrument before you is adapted to work at potentials of from 60 to 120 volts. If the needles were polished aluminum and the cells polished aluminum, we should have none of the difference due to contact electricity. You get apparently $100\frac{9}{10}$ or $100\frac{1}{4}$ when the needles are positive and the cells negative; on the other hand, when the needles are negative and the cells positive you get $99\frac{1}{4}$, the mean being correctly 100 volts. I anticipated this when the instrument was first made, but our first trials of all first instruments within the year of preparation showed such effect to a degree so little that it could barely be perceived. You could barely see $\frac{1}{10}$ of a volt difference. We made more than a year ago a great many careful experiments, and never found more than $\frac{1}{10}$ of a volt. Quite lately my attention was recalled to this by my former assistant, Mr. Rennie, now of the Board of Trade testing laboratory, which has lately been established under the superintendence of Major Cardew. He found with a new instrument recently supplied to that laboratory, a larger difference of just about the amount we originally expected. I have tried new instruments since and found it much greater than in the earlier trial instruments. The explanation is that in the original instruments that were made for trial, with pieces of metal that had been tossed about in the laboratory, and with needles and plates unpolished, the condition of surface was not such as to give the proper difference. But in the finished instruments, with a high polish, a definite difference of this kind, much greater than in the original trial instruments, was obtained.

I received a letter this morning from Mr. Rennie about experiments on an electrometer at the Board of Trade.

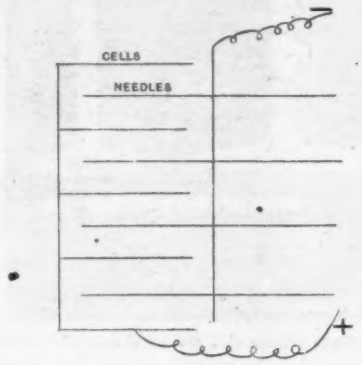


Diagram of Electrostatic Voltmeter.

In the course of these experiments at the Board of Trade, extending over a month or six weeks, and made at frequent intervals, there were doubled differences amounting from .5 to .6. There was evidence of a slight decrease in the error, and it is not all improbable that in time this error may diminish when the initial state of polish may have become toned down. I made one experiment of that kind, subjecting an instrument, just as it stood, both cells and needles, to damping by vapor of water; but the result was not to diminish the difference, but rather to augment it. But exceedingly little change takes place. The explanation is, of course, that polished aluminum is positive to brass, just as zinc is positive to brass, and the effect is of the same kind as would be observed if we had zinc needles and copper cells, the form of contact electricity with which we are most familiar. Let us suppose, instead of being connected to a battery, a metallic connection is made between the cells and the needles; then we shall have a simple contact between aluminum and brass. A direct experiment on the force due to that would show no result. Let us say $\frac{1}{4}$ volt is the difference.

The force due to this difference when the terminals are metallically connected bears to the force due to it, when a difference of 100 volts is maintained between them, the ratio of $(\frac{1}{4})^2$ to $(100+\frac{1}{4})^2-100^2$, or approximately 1 to 800.

On the Form of Submarine Cables for Long Distance Telephony.*

BY W. H. PREECE, F. R. S.

At the Newcastle meeting last year I gave the reasons and experiments which led to the conclusion that telephoning between London and Paris was practicable. New and distinct aerial lines of four copper wires are now being erected by the respective governments from each capital to the coast, and a new cable, the joint property of the two governments, will be laid during this year, between the Kent coast and Sangatte, to connect these two lines. There will thus be two metallic circuits between the two capitals. The $K\,R$, that is the product of the capacity, K, and the resistance, R, of each circuit, upon which the clearness of articulation depends, will be 5,900, indicating that speech should be excellent.

A somewhat similar circuit has been established, since October last, between Buenos Ayres and Montevideo, under my advice. The cables across the La Plata are each 28 miles long, for there are two separate single wire cables, and the total distance between the two cities is 180 miles.

Diagram of Cable Line.

Subscribers, who have metallic circuits in each city, have no difficulty whatever in speaking to each other from their respective offices, although the $K\,R$ is as high as 10,400.

The cable across the Channel will be a four-wire cable, and the specification for its construction has been based on the following mathematical development by Mr. H. R. Kempe.

Let there be a looped telephonic line between A and B, with a cable at C, at an intermediate point on the route.

The working capacity of the whole line is dependent upon the product of the total resistance, R, and the total capacity, K. Therefore, if we take the resistance of the aerial portion of the line to be a fixed quantity, there will be a particular size of cable conductor which will give the smallest possible size of dielectric, sufficient to enable a particular value of $K\,R$ not to be exceeded. For, if we make the conductor larger than this size, and thereby diminish its resistance, we can, it is true, do with an increased capacity, but the diminution in the thickness of the dielectric which could thereby be allowed, is more than compensated for by the fact that the surface of the conductor is larger; in other words, we increase the capacity in a greater proportion than we diminish the resistance. If, on the other hand, we diminish the size of the conductor, we increase the resistance in a greater proportion than we diminish the capacity. Strictly speaking, the requirements of the problem are to determine the size of cable core which shall cost least; but inasmuch as the costs of gutta-percha and copper, bulk for bulk, do not differ greatly, the problem resolves itself into the determination of the smallest outer diameter which can be employed.

Let

r = total resistance of aerial line,
ρ = " " cable,
k = total capacity of aerial line,
κ = " " cable,

Then $K\,R = (k+\kappa)(r+\rho)$,

Let D = diameter of dielectric of cable,
x = " conduc or "

Then $\rho = \frac{a}{x^2}$ and $\kappa = \frac{b}{\log_\varepsilon \frac{D}{x}}$

where a and b are constants.

We have, therefore,

$$K\,R = \left(k + \frac{b}{\log_\varepsilon \frac{D}{x}}\right)\left(r + \frac{a}{x^2}\right)$$

therefore

$$\frac{b}{\log_\varepsilon \frac{D}{x}} = \frac{K\,R}{r+\frac{a}{x^2}} - k = \frac{K\,R - k\left(r+\frac{a}{x^2}\right)}{r+\frac{a}{x^2}}$$

therefore

$$\log_\varepsilon \frac{D}{x} = \frac{b\left(r+\frac{a}{x^2}\right)}{K\,R - k\left(r+\frac{a}{x^2}\right)}$$

therefore

$$\log_\varepsilon D = \frac{b\left(r+\frac{a}{x^2}\right)}{K\,R - k\left(r+\frac{a}{x^2}\right)} + \log_\varepsilon x$$

$$= \frac{r+\frac{a}{x^2}}{\frac{K\,R - k\,r}{b} - \frac{k\,a}{b\,x^2}} + \log_\varepsilon x = \frac{\frac{r}{a}+\frac{1}{x^2}}{\frac{K\,R - k\,r}{a\,b} - \frac{k}{b\,x^2}}$$

$$+ \log_\varepsilon x = \frac{A+\frac{1}{x^2}}{B-\frac{C}{x^2}} + \log_\varepsilon x = u, \text{ say}$$

where

$$A = \frac{r}{a}$$

$$B = \frac{K\,R - k\,r}{a\,b}$$

$$C = \frac{k}{b}$$

Now to make D a minimum we must make $\log_\varepsilon D$ (that is u) a minimum, and this we have to do by variation of x, therefore we have

$$\frac{d\,u}{d\,x} = \frac{1}{\left(B-\frac{C}{x^2}\right)^2}\left\{\left(B-\frac{C}{x^2}\right)\frac{2}{x^3} - \left(A+\frac{1}{x^2}\right)\frac{2\,C}{x^3}\right\}$$

$$+\frac{1}{x} = 0$$

therefore

$$\frac{1}{x} = \frac{1}{\left(B-\frac{C}{x^2}\right)^2}\left\{\left(B-\frac{C}{x^2}\right)\frac{2}{x^3} + \left(A+\frac{1}{x^2}\right)\frac{2\,C}{x^3}\right\}$$

$$= \frac{2}{x^3\left(B-\frac{C}{x^2}\right)^2}\left\{\left(B-\frac{C}{x^2}\right) + \left(A+\frac{1}{x^2}\right)C\right\}$$

$$= \frac{2}{x^3\left(B-\frac{C}{x^2}\right)^2}\left\{B + A\,C\right\}$$

therefore

$$x^2\left(B-\frac{C}{x^2}\right)^2 = 2\left\{B + A\,C\right\}$$

therefore

$$x\left(B-\frac{C}{x^2}\right) = \sqrt{2\,(B+A\,C}$$

therefore

$$B\,x - \frac{C}{x} = \sqrt{2\,(B+A\,C)}$$

therefore

$$x^2 - \frac{x\sqrt{2\,(B+A\,C)}}{B} = \frac{C}{B}$$

From which, by solving the quadratic equation, we get

$$x = \frac{\sqrt{B+A\,C} + \sqrt{B+A\,C+2\,B\,C}}{\sqrt{2\,B}}$$

Now, careful experiments made on an aerial line of copper wire, weighing 200 pounds per mile (diameter = 112 mils), the wire being 30 feet above the ground showed that the inductive capacity per mile was .015 microfarads very nearly, consequently the capacity per mile is expressed by the formula

$$\frac{.061637}{6.1583625 - \log d}$$

d being the diameter of the wire in mils.

From this formula the capacity per mile of a wire

* Read before Section A, British Association, Leeds Meeting.

* Paper read before the Leeds meeting of the British Association.

weighing 400 pounds works out .0156 m.f. The average resistance per mile of a wire of this weight is 2.25 ohms.

Taking the distance between London and Dover to be 70 miles, and between Calais and Paris to be 180 miles, the total distance of the loop will be 500 miles, which for a 400-pound copper wire gives the resistance

$$r = 500 \times 2.25 = 1{,}125 \text{ ohms.}$$

Now, in the case of a looped wire, the total capacity equals half that of a single wire, hence

$$k = \frac{.0156 \times 250}{2} = 1.95.$$

Assuming the length of the cable to be 21 knots, we have approximately

$\rho = \frac{42 \times 74{,}402}{x^2}$ for copper of 98 per cent. conductivity at 60 degrees F., so that

$$a = 3{,}124{,}884.$$

The ordinary standard core used by the Post Office has a conductor diameter of 86.41 mils, and a gutta-percha diameter of 285 mils, and a capacity of 1/3 m.f. per knot; and as

$$\text{capacity per knot} = \frac{\text{const.}}{\log \frac{D}{d}}$$

we have

$$\text{“}1/3 = \frac{\text{const.}}{\log \frac{285}{82.087}}$$

or

$$\text{const.} = \frac{\log \frac{285}{82.087}}{3} = .18018997.$$

The capacity of 42 knots of looped cable will be half that of 21 knots of single cable, hence

$$\kappa = \frac{.18018997 \times \frac{21}{2}}{\log \frac{D}{x}} = \frac{1.8919947}{\log \frac{D}{x}}$$

$$= \frac{4.356481}{\log_\varepsilon \frac{D}{x}}$$

so that $b = 4.356481$

We have then for 400 pounds wire

$a = 3{,}124{,}884$
$b = 4.356481$
$r = 1{,}125$
$k = 1.95$

If we take $K\,R = 7{,}500$, which is the highest value that can safely be taken, we get

$$B = \frac{7{,}500 - 1.95 \times 1{,}125}{3{,}124{,}884 \times 4.356481} = .000389779$$

$$2\,B\,C = \frac{2 \times .000389779 \times 1.95}{4.356481} = .000348937$$

$$\sqrt{2\,B} = .000551231$$

$$A\,C = \frac{1.95 \times 1{,}125}{3{,}124{,}884 \times 4.356481} = .0001611454$$

From this we get

$$\sqrt{B + A\,C} = .02347177$$

$$\sqrt{B + A\,C + 2\,B\,C} = .0299977$$

$$\sqrt{2\,B} = .000551231$$

so that $x = \frac{.02347177 + .0299977}{.000551231} = 97.00014$

and extreme diameter of strand $= 97.00014 \times \frac{100}{95} = 102.1054$ mils.

Since $K\,R = (k + \kappa)(r + \rho)$

we get

$$\kappa = \frac{K\,R}{r + \rho} - k$$

$$= \frac{7{,}500}{1{,}125 + \frac{3{,}124{,}884}{(97.00014)^2}} - 1.95 = 3.197153.$$

But

$$\kappa = \frac{1.89199468}{\log \frac{D}{x}}$$

therefore

$$\log D = \frac{1.89199468}{\kappa} + \log x = \frac{1.89199468}{3.197153} + 1.9867724$$

$$= 2.5785475 = \log \text{ of } 378.86$$

$$= 380 \text{ mils approximately.}$$

If we take

$x = 95$	then $D = 378.94$
$x = 97.00014$	$D = 378.86$
$x = 99$	$D = 379.08$

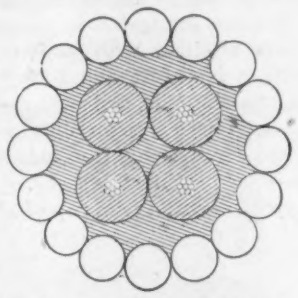
which proves the correctness of the calculation for a minimum.

The values of these diameters correspond very closely to a core, the weight of whose conductor is 160 pounds and the weight of whose gutta-percha covering is 300 pounds, and it has therefore been decided to adopt those dimensions.

Although the calculation has been made on the assumption that the land lines on both sides of the cable are to be of 400-pound wire, the French government have decided that the wires to be erected by them shall be of 600 pounds weight; the result of this will be to reduce the value of $K\,R$ to 5,900, as stated at the commencement of the paper.

The specification of the cable states that: (1) Each conductor shall be formed of a strand of seven copper wires, all of equal diameter, shall weigh 160 pounds per nautical mile, and shall at a temperature of 75 degs. F. have a resistance not higher than 7.632 ohms or lower than 7.478 ohms per nautical mile.

(2) Each conductor shall be insulated by being covered with three alternate layers of Chatterton's compound and gutta-percha, beginning with a layer of the said compound, and no more compound shall be used than may be necessary to secure adhesion between the conductor and the layers of



Section of Telphonic Cable.

gutta-percha. The dielectric on each conductor shall weigh 300 pounds per nautical mile, making the total weight of each conductor, when covered with the dielectric, 460 pounds per nautical mile.

(3) The inductive capacity of such insulated conductor shall not exceed .3045 microfarad per nautical mile.

(4) The insulation resistance of each coil of core shall be not less than 500 megohms per nautical mile after such coil shall have been kept in water maintained at a temperature of 75 degs. F. for not less than 24 consecutive hours immediately preceding the test, and after electrification during one minute.

The cores (four in number) are to be served with the best wet fully tanned yarn, and with a sheathing of sixteen 280 mil wires, each having a minimum breaking strain of 3,500 pounds, and a minimum of 10 twists in 6 inches. The section of the cable is shown by the figure.

The Electric Light in a Theatrical Performance.

Quite a novelty in electrical effects has just been furnished by Messrs. Hatzel & Buehler, of this city, to Primrose & West, the well-known minstrels. Mr. Wm. West

Electric Torch in a Theatrical Performance.

first conceived the idea of introducing the incandescent light in minstrelsy, and that gentleman gave Messrs. Hatzel & Buehler the greatest liberty in carrying his ideas into execution.

The effect is introduced in the portion of the programme termed "The March of the Imperials." Seventeen men, handsomely uniformed in white silk, and each man carrying a nickel-plated drum-major's baton, are marched on the stage headed by Mr. West, who is dressed in a red uniform, and are put through a number of difficult and unique marches and various evolutions, with striking poses.

Each man has a small Edison incandescent lamp attached to the end of his baton, as is shown in the illustration on this page. The conducting wires lead down the inside of this baton about half its length, where they terminate in a small receptacle ingeniously arranged, in which a small plug attached to a flexible cord is fitted. The flexible cord runs down underneath the uniform, and terminates in another small plug which is attached to a receptacle on the back of the shoe. The right shoe is fitted with plates, one on the sole and one on the heel, and wires from these plates lead to the receptacle on the back of the shoe. These shoe plates thus constitute the terminals of conductors to the lamp when the plug is in the baton.

Thirty-four plates are so arranged on the stage that in certain poses each man steps with his right foot on two plates, making contact with the heel and sole plates of the shoe. The plates on the stage are connected to conductors underneath carrying current, controlled by a switch located at the side of the stage. The various evolutions are carried out by count of drum taps, and on certain counts all of the 17 men step on stage plates, when current is switched on.

The effect produced is a very brilliant one, the red, white and blue lamps showing up in a dazzling manner on the darkened stage. During the various evolutions the batons are twirled and juggled, the flexible cord, with attaching plug, being detached from the batons and carried loosely in the belts. Connection to the batons is made just before stepping on the stage plates. Current is only switched on after the men are on the plates.

Messrs. Primrose and West carry eight cells of Gibson storage battery for use in theatres where current cannot be supplied from the regular lighting circuits. The 4 c. p. Edison miniature lamps are used in connection with these. In theatres where current can be obtained 20 c. p. Edison spiral miniature lamps of 55 volts are used, being connected in multiple arc on 50-volt circuits, and where 100 or higher volt circuits are used lamps are connected with two in series. This feature of the minstrel entertainment has been received everywhere with the greatest enthusiasm. The effect can be seen at the Grand Opera House, in this city, next week.

Telpherage System at the Edinburgh Exhibition.

The Electrical Engineering Corporation of London and West Drayton, since securing the sole rights for the telpher system of cheap transportation, has been vigorously developing the system, and it was determined to put up a telpher line on a practical scale at the Edinburgh Exhibition to show the most recent improvements, and to so arrange the line as to carry passengers and demonstrate the advantages of the system for the transportation of goods. As a rule, rigid lines are recommended for the transportation of passengers, but it was thought that the traveling over a slack rope would prove more interesting and attractive to the general public than a rigid rail.

The system comprises arrangements for the transportation of a great variety of material, from minerals and heavy freight to light packages, the lines being constructed for the particular purposes for which they are required. These lines partake of the same general character, having an overhead line, with carriers specially suited for the employment of electricity in the transmission of the power required.

The Edinburgh line consists of over a quarter mile of track, the flexible portion of it being constructed in spans of 50 feet, and the rigid ends in spans of 15 feet. The stand ropes on which the locomotive and carriages travel are of crucible steel and 1¼ inches in diameter. These are tightened, so that with a full load on the line there is a sag of about 2 feet 4½ inches on the spans covered by the train.

The arms supporting the stand rope are arranged so that they move in either direction, allowing the sag in the rope to follow the train as it moves along, thus obviating any undue strain upon the posts themselves. The stand rope at its junction with the rigid rail passes from a special descent junction saddle, so arranged that the train rises from the rope on to the rigid rail without any jerk or other unsatisfactory movement. From the junction saddle it passes directly to a structure termed the abutment post; this is fastened to the substantial anchorages in the ground by flexible steel ropes five inches in circumference. The strain upon the ends of the stand rope with a fully loaded train is about five tons, and the strain upon the anchorages about eight tons.

The current is conveyed along a conductor, which is not attached to the insulators on which it rests at any point, but merely rests upon them. From the locomotive a rigid arm projects underneath the conductor, but above the insulators, and slides along under the conductor, lifting it off the insulators as the arm passes them, allowing it to rest on them again after it has passed. This method of collection, which is recommended in the "Walker-Manville" system of electrical traction, is proving admirably satisfactory.

The locomotive consists of what is termed by the Corporation a swinging tub, and the motor drives a small countershaft, to one end of which is attached an electrical governor to maintain a definite speed; the other end of the countershaft has upon it a chain wheel, which drives directly upon a larger chain wheel contained on the upper

frame. The motor is suspended from the upper frame by a hanger, so arranged as to allow the whole to swing, the swinging movement thus allowed not interfering with the motion of the chain, as it is a movement radially to the centre of the large chain wheel on the upper frame. The upper frame contains, in addition to the large chain wheel, two driving wheels with malleable cast-iron tires to grip the rope, each attached to a chain wheel driven from the shaft supporting the large central chain wheel.

The Robinson Electric Radial Car.

A few months ago we were able to give a preliminary description of the six-wheeled car designed by Mr. Wm. Robinson, of Boston, Mass, the first one of which was in use at that time on the West End Street Railway in that city. We are now able to describe more in detail the construction of this novel type of car and to give the results of some tests which have been made with it in competition with other cars designed for substantially the same service.

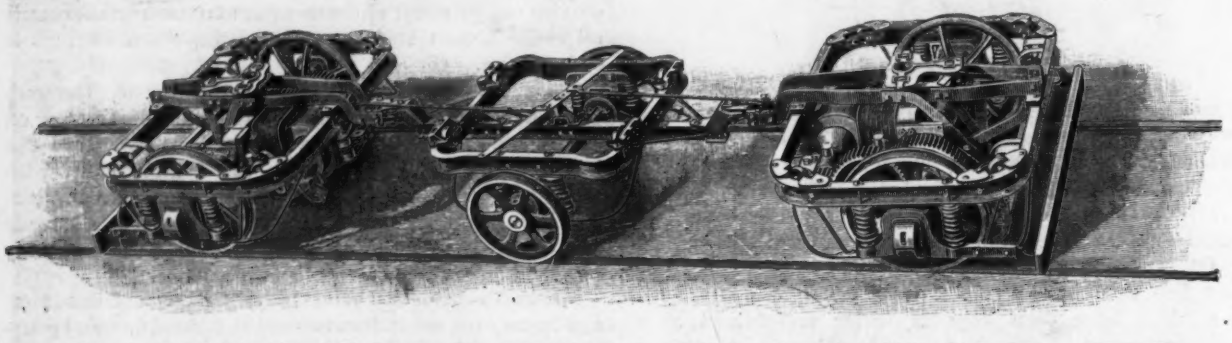


FIG. 1.—ROBINSON'S SIX-WHEELED RADIAL CAR TRUCK FITTED WITH ELECTRIC MOTORS.

Our illustrations show the standard type of truck used with this system and one of the large cars fully equipped with electric motors, which has during the summer been in actual service on the West End road in Boston. Fig. 1 shows the Robinson electric radial truck, upon which are mounted two 15 h. p. Thomson-Houston motors. The truck has three axles—the two outside ones being driving axles and the centre one merely a follower which serves as a support for the centre of the long car body. When passing around the curves the axles all take positions which coincide with radii of the curve. The car body is attached to the truck upon two centres directly over the front and rear axles. The centre axle has a transverse motion underneath the car, this motion being easily made owing to the steel rollers which lie between the truck and the car body, as shown in the illustration. When upon a curve the position taken by the axles secures a minimum of friction between the flange of the wheel and the rail, and thus reduces to the least possible amount the additional power required to propel the car around the curve. The very long wheel base, 15 feet in this truck, secures an opportunity to give the car a very large seating capacity, but does not, as in the ordinary car with short wheel base, permit of any rocking motion in a direction parallel with the track. The result is that these cars are as easy riding as coaches on steam roads.

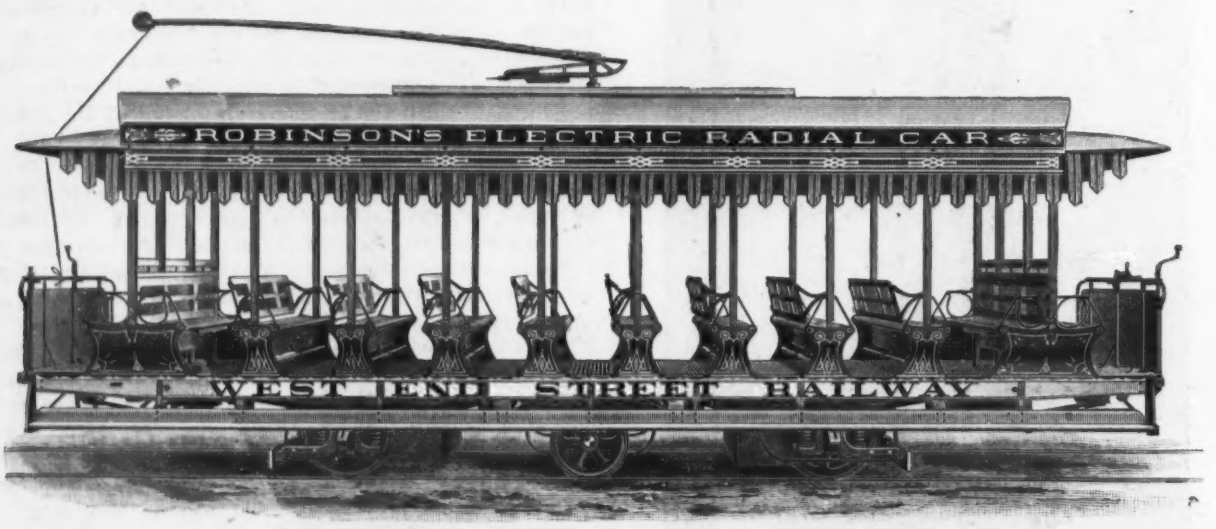


FIG. 2.—OPEN STREET CAR FITTED WITH ROBINSON'S RADIAL TRUCK.

In Fig. 2 is shown an open car, mounted upon a Robinson radial truck, equipped with Thomson-Houston electric motors. The car has twelve benches and a seating capacity for 60 passengers. Its length over all is 44 feet 3 inches, its wheel base 14 feet. This car has been running in regular service on the West End road, between Arlington and Bowdoin Square, Boston, since July 12 last, and has given admirable satisfaction both to the railway managers and to the traveling public. Fourteen of these cars of the closed type, with a seating capacity of 42 each, and a carrying capacity, including standing room, of about 150 passengers, are now nearly completed for the West End Street Railway Company, and will be put in service as soon as completed.

In actual experience and by special tests the inventor claims to have found that the radial car, owing to the decreased friction between the flanges and the rails in rounding curves, requires less power than the eight-wheeled double truck cars of the same weight and load, and he has also observed in an actual test that even upon a straight track the Robinson car requires less power than similar cars of other designs.

This car is adapted for use with all of the electric motors now built, and any one of them may be applied to it. It is also adapted to take its current supply either from the overhead, underground or surface systems, or from storage batteries, as may be deemed advisable in any particular case. The car illustrated is adapted to run at a speed of 40 miles an hour with perfect steadiness and safety, and without any of the end tilting motion of the usual horse and electric cars, and will easily run around a street corner on a curve with a radius as small as 25 feet. It has been demonstrated that it is able to climb heavy grades with ease and considerable speed.

At Newburyport, Mass., a trial trip of 18 miles was very recently made with one of the Robinson radial cars which had just been built at the shops of the Newburyport Car Company. The sharpest curves, some having a radius of only 35 feet, were passed very easily and without any more preceptible friction or jar than on a straight line. All efforts to derail the car by means of obstructions proved unavailing, and when purposely run off the track it was easily returned to the rails. Mr. William Robinson, the inventor of the radial car, is well known in railroad circles as the designer of a system of electric railway signals now in very extensive use on all the leading railroads of the United States. Mr. Robinson formed the Union Electric Signal Company to operate his electric signal inventions, and the controlling interest in this company being subsequently purchased by Mr. George Westinghouse, Jr., and his associates the headquarters of the company were removed to Pittsburgh and the name of the company changed to the Union Switch and Signal Company, which it now bears.

The Indianapolis Electric Street Railway.

The Citizens' Street Railway, Indianapolis, Ind., has been in operation since June 8, 1890, and is claimed to be the best constructed electric railway in that part of the country. The centre pole double bracket construction has been used throughout, the poles being of heavy iron pipe with fancy bracket and arm attached to each side of the pole, extending over the centre of each track, supporting the trolley wire. This construction runs through the business portion of the city. On this line are a number of difficult curves which necessitated the employment of considerable engineering skill in the construction of the overhead system. The company is at present operating 10 motor cars, each equipped with two 15 h. p. motors, and each motor car at all times draws a trail car.

The traffic on this road since starting has been larger than had been anticipated, but the equipment has been in operation for nearly four months without the slightest delay or trouble. The cars were manufactured by the St. Louis Car Company, St. Louis, Mo. The power station is equipped with a 250 h. p. Wheelock engine, Corliss type, and one 500 h. p. Hazelton boiler, and natural gas is used for fuel. Two 30 h. p. Thomson-Houston generators are installed in this station, together with a very handsome marble switchboard, which has upon it circuit breakers, meters and voltmeters, switches, rheostats and potential boards, and taken altogether it is a very fine equipment. The Thomson-Houston Electric Company is at present building a large electric snowsweeper for this railway, which will be used to remove the snow from their tracks during the winter months.

An Improved Friction Pulley.

The fact that hundreds of electric light and power station managers find it necessary to drive several dynamos from one large engine by means of counter shafts and clutches makes the subject of friction pulleys and cut-off couplings an important one to central station men. We illustrate herewith an improved form of pulley, of which the fundamental patent was granted to the Friction Pulley Company, Sept. 21, 1886. The improvement has been made by the Friction Pulley and Machine Works, of Sandy Hill, N. Y., and a patent has been applied for to cover the new form of pulley.

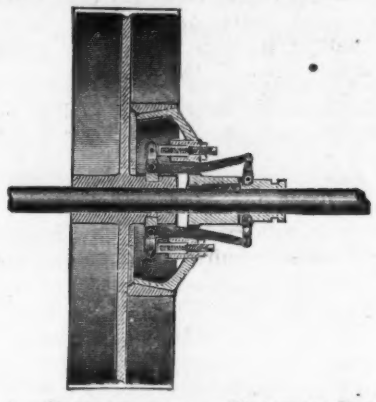


FIG. 1.—CROSS-SECTION OF FRICTION PULLEY.

Considerable trouble was experienced with the old form from the breaking of the cast steel toggles. To overcome this difficulty the construction of the pulley has been simplified, and the toggles are now all made of forged steel, making a durable and efficient piece of apparatus. The construction will be readily seen from the accompanying illustrations. Fig. 1 is a sectional view through the centre of the pulley, and Fig. 2 shows the appearance of the pulley complete when attached to a shaft.

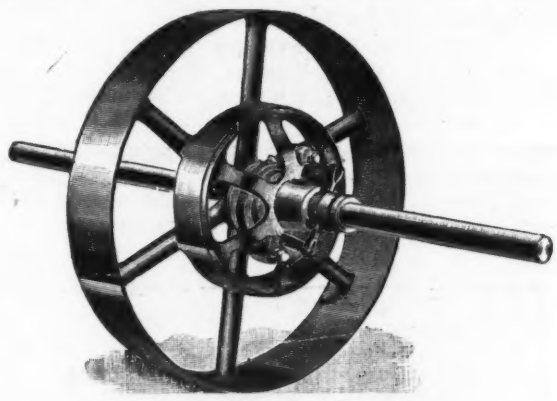
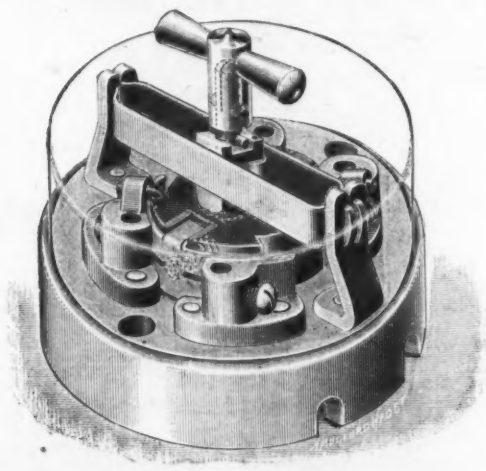


FIG. 2.—FRICTION PULLEY.

The Perkins Electric Switch.

The accompanying illustration shows a very ingenious and efficient type of snap switch, the invention of Mr. C. G. Perkins, of Hartford, Conn. As will be clearly seen from the cut, the central spindle of the switch has mounted upon it a square block of insulating material which is loosely pivoted to the spindle. This block is held firmly clamped between two parallel springs secured at their ends to posts carried upon the base. When the handle of the switch is turned, a pin through the centre of the spindle engages with a notch in the loosely mounted block, and the springs are forced outward, allowing the block to turn between them. When turned a quarter of a revolution the contacts are suddenly made or broken, as the case may be, by the snap motion produced by the pressure of the springs against



AN IMPROVED SNAP SWITCH.

the side of the blocks and by the slight freedom of motion which the block has upon the spindle. These switches are made with porcelain bases, are simple, strong and reliable, and very efficient. They are made for use either with concealed or cleated work and in capacities ranging from 10 to 100 ampères and in both single and double pole types.

The Willatt Electric Drill.

It is reported from London that an electrical drilling machine, designed by Mr. W. H. Willatt, electrical engineer to the firm, has just been brought into operation at Messrs. Earles' Shipbuilding and Engineering Company's Works. It has been designed for use on H. M. SS. "Endymion" and "St. George," now being built at Earles', its special purpose being to drill the holes in the two and a half inch steel protective decks to receive the armor bolts. This deck is curved and sloping, and thus renders drilling by hand or machine very difficult. The drilling machine stands on three legs, each of which are powerful compound electromagnets, and capable of lifting 1,000 pounds of iron apiece, and have eccentric wheel casters attached to each leg, so that the machine is quite portable. When the machine is brought over the place required to be drilled, these eccentric casters are turned up, thus allowing the magnets to come into contact with the steel deck; the current is then switched on, and they grip to the deck without any further bolting down. The machine carries an electric motor for driving the drill. A hole two and three-eighths inches in diameter can be drilled through the two and a half inch steel deck in 21 minutes. In the Royal Dockyard, at Devonport, to drill similar holes in a similar ship it takes two men half a day. The current is obtained from the electric light mains, fitted to light the numerous compartments of the ship during construction.

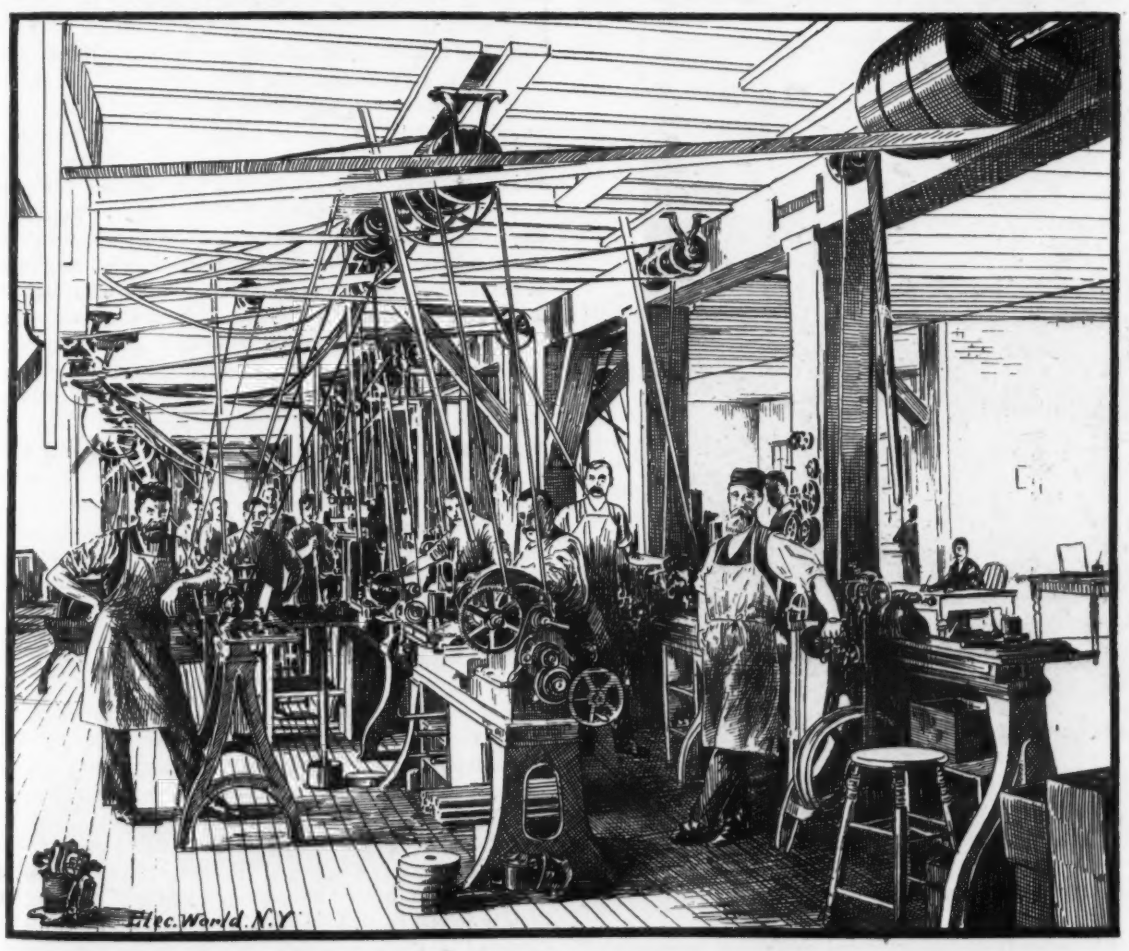
New Factory of the Crocker-Wheeler Motor Company.

The marked success of the various styles of small motors recently brought out by the Crocker-Wheeler Motor Company has created a demand for motors of larger size, possessing the same general characteristics, and in order to meet this demand the company has been compelled to make extensive additions to its plant. The illustration on this page shows an interior view of the machine room of the new factory at the corner of Fourteenth and Washington streets, in this city. This room is 206 × 50 feet, and is located on the second floor of the company's factory. It is equipped with the most improved machinery, carefully selected for this special use.

Besides devoting a large amount of time to the perfection of its small motors, the Crocker-Wheeler Company has lately turned its attention to the construction of small motors for 500-volt circuits, and is turning out motors of this class containing the same points of excellence which have made its motors of other types so popular. It is thought that the rapid growth of electric railway systems, since they are operated upon 500-volt circuits, will open up an immense field for motors of this class, and enable the companies supplying such a current to add very materially to their revenues. The company proposes to give special attention to the needs of people who may be situated along the lines carrying such current, for the reason that the current will be continuously supplied in most cases for 24 hours a day. This will enable proprietors of hotels, restaurants and stores which continue business during the evening, and manufacturers who are depending on electric power, to secure such power whenever the exigencies of business may require it.

In addition to the construction of motors for 500-volt circuits the company is also manufacturing the various sizes of motors for circuits of 110 and 220 volts, and also for other voltages. Besides this the company is at present doing a large business in motors for arc light circuits. A 5 h. p. motor recently finished by the company is of considerable interest owing to the fact that it is thought to be the most compact motor that has ever been built. Its weight is less than 500 pounds, and it develops more than 5 h. p. at 900 revolutions per minute.

The company anticipates that it will be necessary, notwithstanding its present facilities, to double the capacity of its works as soon as it has completed arrangements for the manufacture of various larger sizes of motors.



INTERIOR VIEW OF THE CROCKER-WHEELER ELECTRIC MOTOR FACTORY.

The Writing Telegraph.

Careful observation and experience in a commercial way has enabled the Writing Telegraph Company of New York to find out what was requisite for a practical commercial instrument for electric writing, and to adapt the instruments to the desired work. The company is convinced that its instruments are now as nearly perfect as they can be, since they possess both simplicity and efficiency.

The instruments are fully adapted for private lines, for news reporting and for central exchange purposes. The company claims that its manner of writing can be learned in a few minutes. It insures a fac-simile reproduction at all times and it is said that most parties admit, after a little practice, that it is an easier way to write than to write direct on paper with an ordinary pen. The instruments, as improved, are now inclosed in cases about 12 inches long, 10 inches wide and 8 inches deep. One of these cases is shown in Fig. 1. On the top of the case is shown the paper, the writing stylus and the receiving pen. There are no switches for the writer to manipulate, as such work is all automatic.

The cover is to be closed when the instrument is not in use. A message can be received when the cover is down and is duly recorded whether any one is present or not.

FIGS. 1 AND 2.—CASE AND DESK STYLES OF THE WRITING TELEGRAPH.

These cases can be put on brackets against the wall, but nicely made stands are also furnished sufficiently high for the greatest ease in writing.

Rolling-top business desks are also furnished containing the instruments. These desks are made in the most substantial manner, and have the necessary drawers, pigeon holes and space for ordinary writing of a general business desk. The instrument is placed on the left—convenient for use at any time. These desks are 33 inches wide and 44 inches high. Fig. 2 shows this desk open. For private residences the instrument is placed in a handsome desk. suitable for any library. Besides the instrument, the desk contains all the conveniences of a library desk. This desk is 26 inches wide and 42 inches high.

Some Rapid Work in Electric Railway Construction.

A complete electric railway equipment was recently finished at Elmira, N. Y., which for rapidity of installation eclipses anything heretofore done in this line of work. On the 30th of July the Elmira & Horseheads Railway Company placed a contract with the Edison General Electric Company for the equipment of 7,000 feet of track, six motor cars and a full station outfit. At the same time a contract was placed with the John Stephenson Car Company for six new cars. The contracts were made in both cases with a strong guarantee to the effect that the roads should go into operation on the first day of September in order to accommodate the Interstate Fair, which was to open on that day. The filling of this contract necessitated some very rapid work. Both the Edison Company and the Stephenson Company put their best men upon the work, and forwarded supplies with the utmost possible dispatch. On or about the 15th day of August the Stephenson Company informed the Sprague Company that its cars were ready for equipment, and at about the same time the motors were shipped from the Schenectady works of the Edison Company, which have a capacity of from 15 to 20 street car motors per day. The strike on the New York Central at this time was likely to cause very serious delays, as the cars were to be equipped in New York. A special consultation of the Edison Company and the Stephenson Company was held in Schenectady, with the result of causing the motors to be shipped via the Delaware & Hudson Railroad and the Delaware, Lackawanna & Western Railroad, a roundabout route, which necessitated special cars and unusual service. About the 20th of August the completed cars began to go out from the Stephenson factory, two being shipped each day. In the meantime a contract had been placed with the Simplex Company of Boston for the feed wire; the Edison Company had forwarded all line material and supplies, and everything was on the ground but the poles, which were held in Northern New York, awaiting arrival of cars which had been delayed on account of the New York Central strike. In this emergency, every one turned in to help. Poles were gathered about Elmira, and at 12 o'clock on the night of Aug. 23 the street construction work commenced. Provision for the dynamo and appliances had been made by engaging a part of the Westinghouse station at Elmira. On

Aug. 31 notice was sent to the railway company that the road would commence operation on the following morning, and promptly at 6 A. M. on the first day of September the road carried its first passengers. For the next few days the tests of the machinery were excessive, the cars frequently having to carry two loaded trailers, and to remain in service from early morning until late at night. The largest number of passengers carried by these electric cars with their complement of trail cars was a little over 25,000 in one day. The operation of the road was entirely satisfactory in every respect.

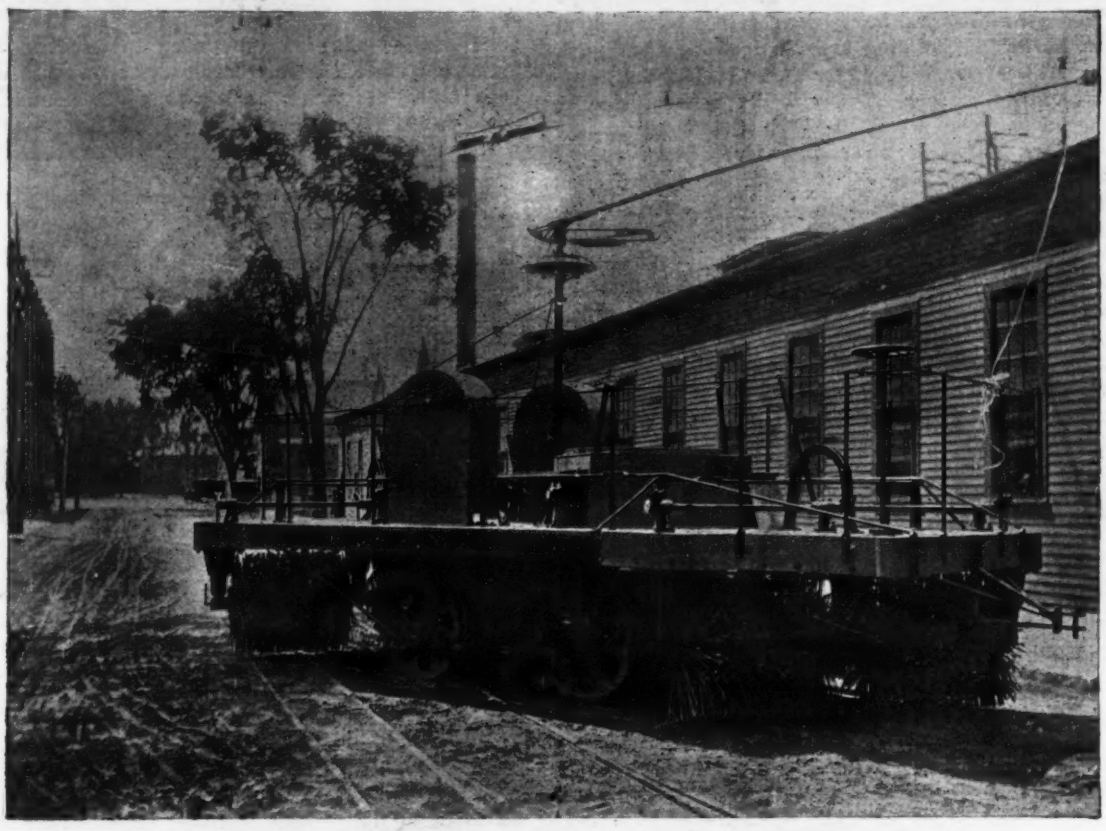
Thomson-Houston Electric Snow Plow and Sweeper.

Past experience in operating electric railways in winter has demonstrated the fact that some appliance is needed for keeping the tracks as free from snow as possible. That the Thomson-Houston Electric Company fully realized this is shown by the forethought manifested in preparing the snow plow and snow sweeper shown in the accompanying illustrations. Last winter's experience with snow showed just what was needed in this direction, and in the new appliances will be found many improvements over the old types, which clearly proves that past experience has been turned to advantage.

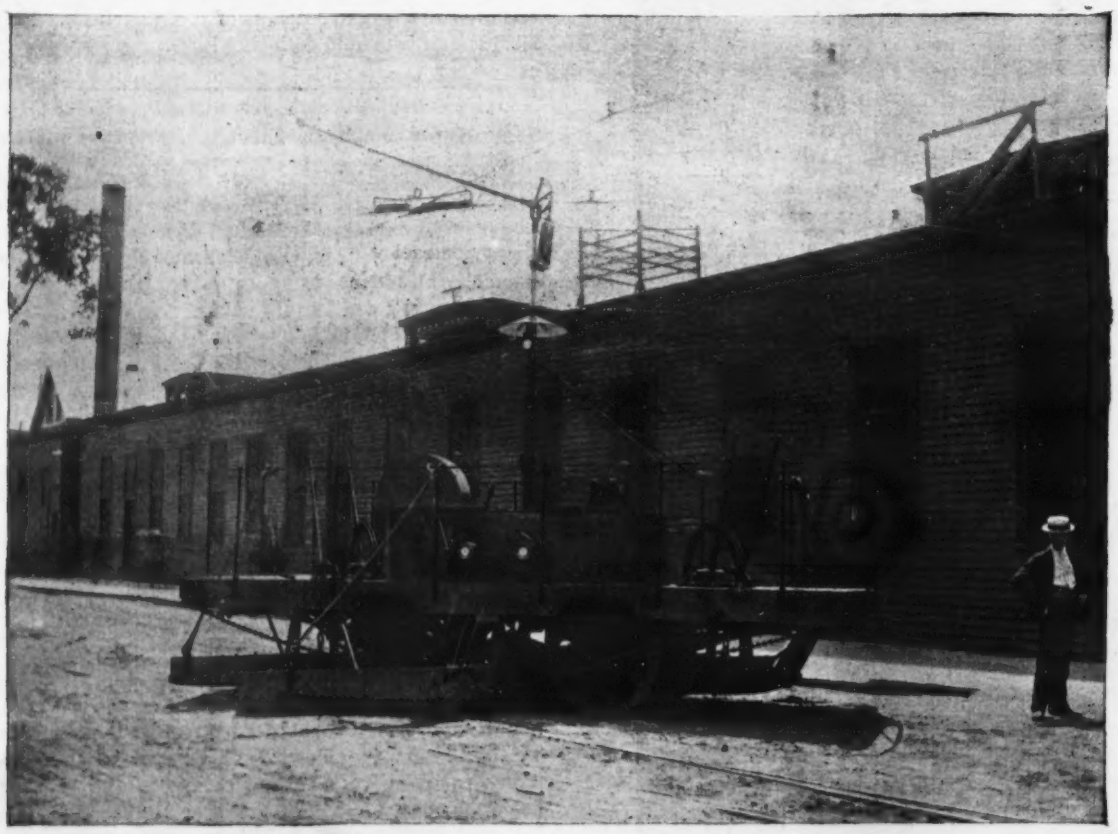
The details of the snow plow are as follows: Length over all, 20 feet; width, seven feet; height from rail to floor of car three feet six inches. The truck has four 36-inch wheels, in front of which is placed a digger which scrapes the snow from the track, thereby securing a good contact for the wheels. These diggers, or scrapers, are controlled by levers placed at each end of the car, and may be raised and lowered at will. One of the main plows is placed diagonally across the car, one end being in front of the forward wheel on one side, at an angle of about 60 degrees. By placing the plow in this manner a position is secured where the least oscillation occurs. Although the plows extend two feet beyond the wheels, each is provided with an extension by means of which a path of any desired width, depending upon local conditions, can be plowed out. The second main plow is hung parallel to, and in the same manner as, the first, each, however, being independent, and controlled by levers placed upon the car platform. One or both can be used as the circumstances require. The plows are kept at a proper angle by means of chains and iron rods, so arranged as to permit great freedom of movement in a vertical direction.

The car is propelled by two 20 h. p. motors, of the consequent pole type, one being geared to each axle by means of sprocket chains and chain gear wheels, and they are capable of propelling a car at a speed of 10 miles an hour. The sprocket chains run as slow as possible, since the total reduction in speed is made by gears on the motor frames. They are inclosed in iron boxes. In circuit with the motors is placed a reversing switch rheostat, also placed in a closed iron box. The trolley arm is supported by a post placed in the centre of the car platform, and this is also used as a support for a number of incandescent lamps. The car can be operated in either direction.

The car for the snow sweeper is of the same dimensions as that used for the plow, the wheels being 36 inches in diameter, and mounted on a 3¼-inch axle. The motors for driving the car are of 15 h. p. each, and are entirely independent of the motors used for driving the brushes, being provided with separate reversing switch and rheostat, inclosed in an iron box, and placed on the platform in easy reach of the operator. The motors for operating the brushes are placed on the car platform, with a shaft parallel to that of the broom, and connected to it by means of sprocket chains, so as to run at a speed of 200 revolutions per minute. The brushes, which are placed in advance of the truck, are two in number, and are made in sections to facilitate taking apart and placing upon the drum to which they are fastened. On the platform of the car on both sides are handles operating clutches by means of which the brooms can be thrown in or out of operation. Levers are also provided for raising and lowering the brooms, thereby rendering it possible to operate them at any desired height. To insure the snow being thrown off the track the brooms are set at an angle of 60 degrees to the rail. The electrical connections are the same as found on the passenger cars, the motors for propulsion being connected in multiple, but independently of the motors used for driving the brushes. The current is taken from the overhead conductor by means of a trolley, supported on a post eight feet high, placed in the centre of the car. Around this post are grouped incandescent lamps, which are employed when the car is required for night service. Both the snow plow and sweeper are made for severe work, and have proved in previous tests to be fully capable of responding to every demand made upon them.



SNOW SWEEPER EQUIPPED WITH THOMSON-HOUSTON ELECTRIC MOTORS.



SNOW PLOW EQUIPPED WITH THOMSON-HOUSTON ELECTRIC MOTORS.

Electricity at the Pittsburgh Exposition.

The second annual exposition of the Western Pennsylvania Exposition Society opened at Pittsburgh on Sept. 3, and will close Oct. 18. The "show" is an admirable one in every way. Great care has been taken and excellent taste shown in the arrangement of the various exhibits, and the result must be beneficial to the exhibitors. The advertising power of displays of this kind is not small. The employment of electricity greatly enhances the attractiveness of the Exposition. Nightly every nook and corner of the two large buildings is brilliantly illuminated by the electric lamp, arc and incandescent. And even the most careless on-looker cannot fail to observe that the electrical exhibits to be found in Mechanical Hall are considered by the sight-seeing public as, on the whole, the most interesting things brought forward for attention.

Pittsburgh being the home of the Westinghouse Electric and Manufacturing Company, it is natural that that enterprising corporation should be well represented at the Exposition. The space allotted to the Westinghouse people is crowded with objects calculated to interest the visitor. At the end of the exhibit adjoining the entrance to the hall is stationed a 3,000-light alternating current dynamo, driven by a 400 h. p. Westinghouse rotary engine. The dynamo is very handsome and the engine is as unique and pleasing in appearance as it is novel in its workings. As is well known, it is the invention of Mr. George Westinghouse, Jr., and that gentleman has spared no pains to bring it to perfection. The next neighbor to the 3,000-light dynamo is one of 1,500 lights, which has as its motive power a Westinghouse compound engine of 250 h. p. Then comes a 750-light machine and a 500-lighter (the latter the smallest alternating current dynamo manufactured by the Westinghouse Company for central station purposes), each driven by a Westinghouse "Junior" engine. Next stands a 25-light alternate current arc dynamo, and beyond it a 30 h. p. Tesla motor generator. These six machines stand in a direct line, and form a stately column. A number of Tesla motors are employed for different purposes throughout the building; one runs a caramel wrapping outfit, another operates a soap wrapping machine, and a printing press is quietly and effectively kept working through the agency of a third. Still another furnishes motive power for the working of the Hercules mining machine. A very neat little piece of mechanism is the Shallenberger fan motor, which can be used on either the alternate or direct current. This motor is also designed for the running of sewing machines, and in the exhibit is a machine which is going constantly, and around which the women crowd from nine o'clock in the morning until ten o'clock at night to hear the explanations of the operator and to declare that a motor on a sewing machine ought to remove a vast deal of labor. An artistically fitted up booth occupies one corner of the Westinghouse exhibit, and into this the weary are invited to enter and rest while seeing immediately to the front a large collection of the details manufactured by the company. Among these are converters, meters and resistance boxes. An egg, copper plated by electricity, spins merrily around upon a plate the livelong day. And there are numerous other devices to please and entertain. All in all, the Westinghouse people have reason to feel pride in the effort they have made, and it would not be possible within the compass of this brief article to do justice to their display.

The Standard Underground Cable Company has a complete collection of its wares artistically arranged in a handsome case. Few persons pass the many sized wires by without making an examination.

R. D. Nuttall & Co. show to the visitor an electric street car trolley, the invention of Mr. W. H. Emmett. This device is said to possess many advantages.

The Hercules Mining Machine Company has a complete

outfit on hand, and it is well worth a close examination. It has the appearance of something that "means business," and judging from the celerity and sinuosity with which the cutting portion of the machinery revolves, one is led to believe that the Hercules mining machine might be capable of boring through adamant. As a full description of this recent addition to electrical machines has lately appeared in THE ELECTRICAL WORLD, it is unnecessary to go into details concerning it.

Opposite the Westinghouse headquarters are found those of the Thomson-Houston Electric Company. The walls in this apartment are prettily draped with the flags of all nations. "We have done this," said a representative, "because the Thomson-Houston system is in use the world

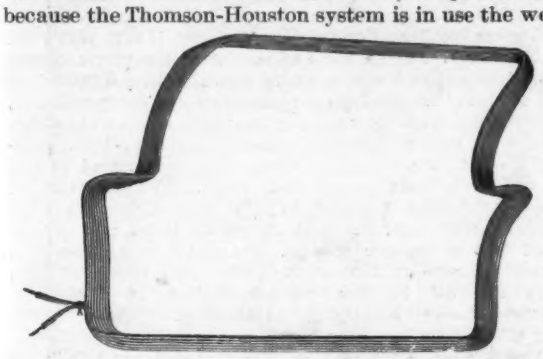


FIG. 1.—SINGLE COIL OF EDISON-EICKEMEYER ARMATURE.

over." A 260 h. p. automatic engine, manufactured by Russell & Co., of Massillon, O., furnishes motive power for the entire Thomson-Houston exhibit, which has a large dynamo capacity. First comes a 650-light alternating current machine, and attention is called to the fact that upon the exciter of this machine is being used instead of the ordinary copper brush one of carbon. Then comes a 35-light arc dynamo, and close beside it is stationed a 450-light incandescent machine of the direct current type. Next is found a 30 h. p. generator, the motors propelled

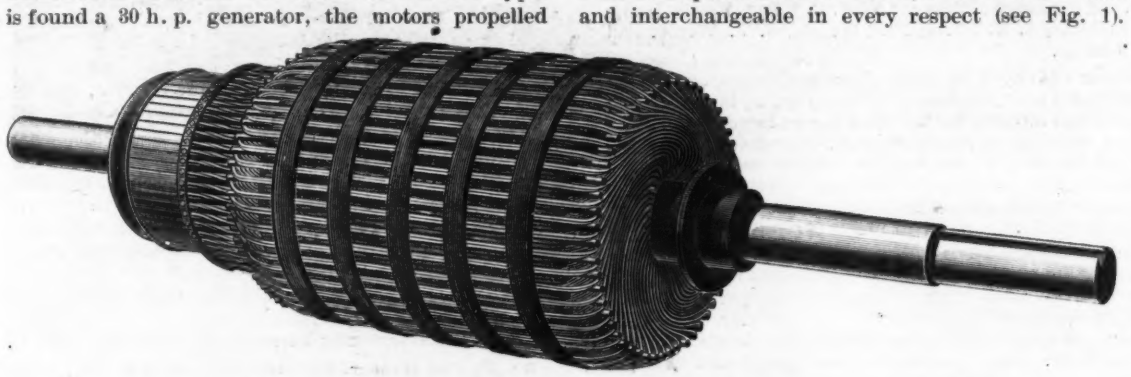


FIG. 2.—THE EDISON-EICKEMEYER STREET RAILWAY MOTOR ARMATURE.

by which are scattered about the building to furnish power for various kinds of work. One of these motors is used in the manufacture of ice cream and another drives a cider press. The engine is connected to the several dynamos by 25 feet of shafting of the well-known Cuyahoga Falls (O.) manufacture. There will be added to the Thomson-Houston exhibit in the near future an electric welding machine, which will doubtless prove a great attraction.

Outside the buildings, at night, two highly pleasing sights greet the eye: One is the electrical fountain of the

MCLAUGHLIN'S SECONDARY BATTERY.

Thomson-Houston people, from which the water ascends in many hued jets 30 feet in the air. The other is the arch of the Westinghouse Company, upon which is inscribed in the handwriting of 16 c. p. lamps these words: "Westinghouse—Pioneers of the Alternating Current." It is safe to say that not one person visiting the Exposition after nightfall neglects to observe the Westinghouse arch and the Thomson-Houston fountain. The efficient lighting of the exhibition buildings is done by the Allegheny County Light Company, Hughes & Gawthrop and the Westinghouse Electric and Manufacturing Company.

The New Edison-Eickemeyer Street Railway Armature.

The Edison General Electric Company has secured for its railway system the use of the Eickemeyer patents for winding armatures. This combination makes a striking advance in railway motor construction. It will be remembered that the Eickemeyer dynamo for lighting purposes was brought out about two years ago, and created much discussion and favorable comment in the press. Since that time it has been actively exploited and it is said that not a single dynamo armature wound on the Eickemeyer plan has ever burned out. The Edison Company has made a thorough examination of this winding, with a view to adopting it for its railway motors where it will be particularly valuable.

The armatures now used by all the leading electric railway companies are wound on what is known as the Siemens system, which has proved entirely suitable for dynamo work, but has some disadvantages in railway motor construction. In Siemens armatures the wire is so wound that, when completed, there is an irregular cone-shaped mass of wires at the end of the armature which have more or less motion among themselves. This motion has a tendency to abrade the insulation of the wires, causing short circuits of adjacent coils which may in some cases carry the maximum difference of potential, and it is in this way that burn-outs frequently occur. Moreover, as the wire is wound in two complete layers, and as burn-outs more frequently occur on the under than on the upper layer, the expense of repairing a burn-out often amounts to nearly as much as that of rewinding the entire armature, since all the coils originally put on after the burned-out coils must be removed in order to reach the latter.

The Eickemeyer system of winding is radically different from the Siemens. Each armature coil is wound upon a "form" of peculiar construction, which makes it standard and interchangeable in every respect (see Fig. 1). In building the armature, the laminated iron core is first prepared as in the Siemens armature, and upon this are loosely placed the necessary number of standard coils, which are locked in place around the armature by means of the wooden pegs, shown in Fig. 2. The result is that square ends are obtained instead of the cone-shaped ends of the Siemens armature. The coils are held firmly in place with absolutely no chance for motion, and there is no mechanical pressure from coil to coil which would tend to injure the insulation and cause short circuit. The armatures are necessarily of standard diameter and interchangeable, and it is believed by the Edison Company that the Eickemeyer armature will never burn out except from an over-load so severe as to cause melting of the wire, from accidental mechanical injuries or from short circuits due to outside causes. If, however, an armature coil should burn out from any of the causes mentioned, it could be replaced without difficulty by any ordinary mechanic and without return to the factory, the whole operation consuming about a day's time and a small amount of material. The railway company would be provided with a sufficient number of standard coils to be held in reserve.

From Fig. 2 the peculiar curvature of the coils at the rear is easily seen. The same curvature is found at the front end. The whole armature is perfectly ventilated, particularly at the front where difficulty has frequently occurred.

It is the opinion of the Edison Company that one of the most serious difficulties that has been met in electric railway work is entirely overcome by the use of this method of armature winding, which has been adopted for all of its railway motors.

McLaughlin's Secondary Battery.

Our illustration shows a new type of secondary battery, which is the invention of Mr. McLaughlin, of Philadelphia, Pa. The plates are composed of solid active material, no perforated plates or grids being used in the construction of the cell. Each plate weighs a pound and a quarter, making the total weight of the battery, including connections, 16 pounds. Each cell contains 11 pairs. It is claimed that with this style of plate there can be no buckling, twisting or warping of the plates in any way, and that owing to this rigid construction of the plates they will endure a very heavy rate of charge and discharge. The capacity of the cell illustrated is said to be 360 ampère hours.

A Combined Motor and Ventilating Fan.

One of the most useful applications of the electric motor is shown in the accompanying illustration. A disc ventilating fan 30 inches in diameter has an electric motor of the "C. & C." type mounted directly on the shaft and supported by the fan brackets. The speed of the armature, which in this case is 600 revolutions per minute, is therefore the speed of the fan. The installation from

"C. & C." MOTOR AND VENTILATING FAN.

which the accompanying cut is taken is located in the building of the Union Trust Company on Broadway in this city, and is capable of delivering 20,000 cubic feet of air per minute.

This method of mounting the motor in direct connection with the shaft of the fan avoids any noise which might accompany the use of a belt or gears, and permits of a much more compact arrangement than could otherwise be obtained. Another advantageous feature of this combination is the ease and readiness with which it may be placed in position without regard to the location of shafting or belts. The "C. & C." Motor Company has found a very large demand for ventilating plants of this type, and has placed many of them in various locations requiring a neat, compact and efficient apparatus.

A Reflector for Electric Chandeliers.

Manufacturers of gas chandeliers have lately been giving considerable attention to the construction of combination gas and electric chandeliers. Mr. I. P. Frink, of this city, has been giving special attention to the construction of reflectors for both large and small chandeliers, and for use

AN ELECTRIC LIGHT REFLECTOR.

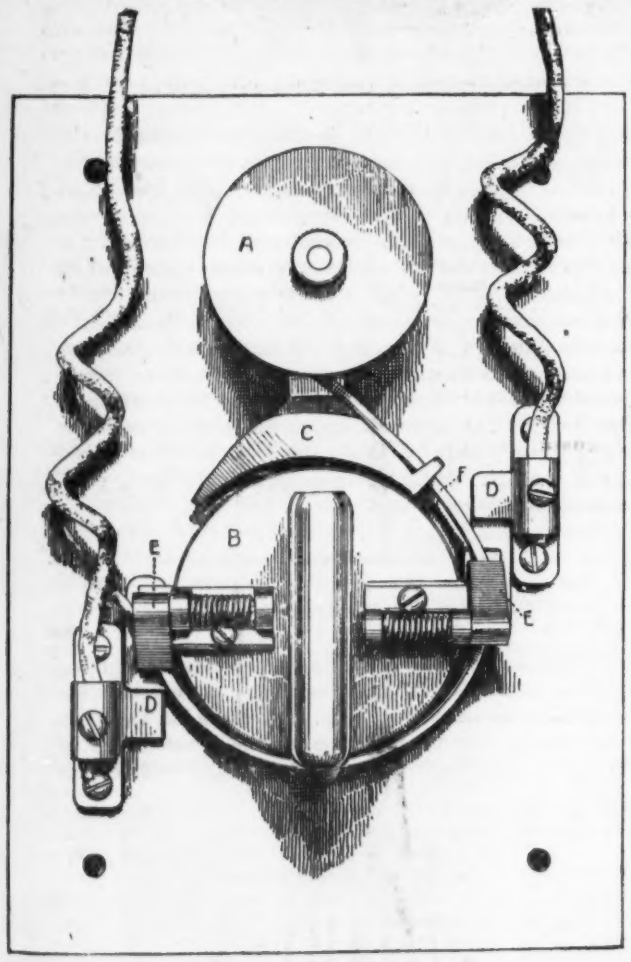
with either gas or electric lights. Our illustration shows a reflector of Mr. Frink's construction used in connection with a cluster of six incandescent lamps. The reflector is so constructed that the audience room in which it is placed is thoroughly illuminated, the light being evenly diffused throughout the room. As will be seen, the reflector is built in a substantial manner and has a neat and ornamental appearance. Reflectors of this style have been placed in many large churches in all parts of the country. The same style of reflector is built to suit the great variety of chandeliers using either gas or electric light, or both in combination.

A Successful Electric Railway.

The Joliet (Ill.) Electric Street Railway Company, which has adopted the Thoms n-Houston electric railway system, completed the electrical equipment of its road and was put in operation Feb. 3, 1890. It is four miles in length, part of it being built with bracket suspension and the remainder with the cross suspension method. The overhead line is built upon painted cedar poles 30 feet in length. It has a number of sharp curves and several crossings and switches, for which the overhead line is arranged. It has had since starting an exceedingly heavy traffic, but has been in constant operation without the slightest delay or trouble. The company is at present operating nine motor cars, each equipped with two 10 h. p. railway motors. The power station is equipped with two 80 h. p. Thomson-Houston generators, with switchboard fitted with all the necessary appliances for the manipulation of the current. The managers of this road are so well pleased with its operation that they have placed orders with the Thomson-Houston Electric Company for additional equipment.

A New Magazine Fuse.

Our illustration shows a new magazine fuse to be placed upon the market by the Automatic Switch Company, of Baltimore, Md. This device is intended chiefly for use on electric street cars, but will be found useful in any position where it is necessary to replace a burned fuse rapidly and with no danger to the operator. Central stations will also



An Improved Magazine Fuse.

probably find this mechanism convenient for use on motor circuits.

By referring to Fig. 1 the construction and operation will readily be understood. *A* is a spool of fuse wire of sufficient size to replace 100 burned fuses. *B* is a slate disc operated by the handle and carrying the spring clamps *E*, between which the fuses are burned. *C* is a wedge-shaped device, by which the spring clamps are opened and the remains of the burned fuse released, leaving the clamp free to take hold of a new piece of fuse at *F*. *D D* are only in connection with the fuse when in the position shown in Fig. 1, thus avoiding all possibility of burning the fuse before the clips have firm hold of it.

As nothing but slate and metal are to be used in the construction of this piece of station apparatus, there is every reason to believe that it will be fireproof, and as a circular break of nearly six inches is produced, circuits of any ordinary voltage should be easily interrupted.

A Telephone Decision in Germany.

The news comes from Germany that until lately the German post office has arrogated to itself the sole right of erecting or licensing private telephone installations, thus prohibiting the development of a most convenient means of communication and excluding the legitimate industry from a branch which ought to be its domain. The well-known telephone manufacturing company, Actien Gesellschaft Mix and Genest, Berlin (whose branch in London is the International Electric Company, 34 Aldermanbury, E. C.), determined on principle, and in the interests of the telephone world at large, to try the point in a court of law. To this effect they brought an action against the German Government claiming that: "It (the German post-office) had no right to restrain or prohibit the plaintiffs to erect and maintain private telephone installations (*a*) between buildings belonging to the same landlord but situated at a distance from each other and separated by property of other landowners, or by public roads or otherwise; (*b*) between property belonging to different landlords—*i. e.*, from one part of a city to another." This claim was decided on the 10th of July in the Royal High Court of Justice of Berlin entirely in favor of the plaintiffs, thus putting an end to a state of things which has lasted so long to the disadvantage of all those interested in this daily progressing industry.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York, Sept. 29, 1890.

Mr. T. F. Hunter, an old supply man, is now with The E. S. Greeley & Co., 57 Dey street, this city.

Mr. Wm. Courtenay, of vulcanized fibre fame, 14 Dey street, this city, and Wilmington, Del., is in Europe for business and pleasure and will return about the middle of October.

Change of Firm Name.—At a meeting of the board of directors, held Sept. 20, it was decided to change the name of the "Haz azer & Stanley" corporation to "Stanley & Hall," and the company will hereafter be known by the name of "Stanley & Hall."

Electrical Abecedarians.—Alexander, Barney and Chapin have issued to their friends invitations to the formal opening of their supply house at 20 Cortlandt street on Monday Oct 6. Apparently they propose to take the inner man as well as the outer by storm, for the accompanying menu fairly seethes with the terminology of an electrical cuisine that would drive the most accomplished chef to suicide from envy.

The Catskill Illuminating and Power Company has been incorporated to manufacture and use dynamos, lamps, motors and storage batteries, and generally to supply electricity for lights, power and other uses to the inhabitants of Catskill and Greene counties. The capital stock is $45,000, divided into 1800 shares of $25 each, and the incorporators are W. S. C. Wiley, Edwin Lampman, J. A. Cooke, A. M. Young, Fred Werner, J. J. Werner and Stanley Vincent.

Mr. Peter Claus, of the Easton Electric Company, 45 Broadway, has secured a large amount of business during his short connection with this company for the Claus-Easton incandescent dynamos. Two dynamos of 500 lights each, two generators of 200 ampères and 500 volts, one combination dynamo and engine on one base, were recently sold to the Seely & Taylor Manufacturing Company, 24 Cortlandt street, for a new steamer of the Brazilian Steamship Company.

Estimates for Lighting New York City.—Commissioner Gilroy sent to Mayor Grant last week his estimate for conducting the Department of Public Works during the coming year. He asks for $3,357,370, as against $3,219,215 allowed for this year. The greatest increase asked for is $126,000 for the Bureau of Lamps, Gas and Electric Lighting. It is explained in the statement that 1,100 gas lamps will have to be purchased and placed at a cost of $18,000. Fifteen electric lights to be placed in the East River Park will cost $2,464. The estimate also provides for the relighting of 465 electric lamps at 43 cents per night—a total for the year of $73,000.

The Elektron Manufacturing Company, 79-81 Washington street, Brooklyn, makers of Perret electric motors and dynamos, have lately added 5,000 square feet more floor space and have the main floor directly off Washington street. The first floor is used for assembling dynamos and motors, testing, shipping, etc.; offices and draughting department, the third floor for machinery and the fourth floor for winding, etc. This company has lately shipped seven 15 h. p. motors to drive ventilating machinery in a mine in Ohio, to run at 550 revolutions. The company is fitting up the St. George Hotel, Brooklyn, with motors. The first sale was for a small motor to run an exhaust fan, then one was sold for a knife scouring machine, then followed one of 4 h. p. for dish washing machinery, and the last order was for a 10 h. p. for running the laundry. The St. George Hotel obtained such fine results with the first motor in quiet running, ease of attendance and such a small amount of trouble that they concluded to abandon their several steam engines and replace them with Elektron motors. Current is supplied from an isolated lighting plant. The company is now building electric hoists from 5 to 20 h. p. to run on docks and other similar locations.

Cable Laying on the New York and Brooklyn Bridge.—After several interviews and the making of all sorts of affidavits that no injury would be done to the bridge structure, a permit was secured for laying cables on a certain day. Work was started Sunday, Sept. 7, on the laying of five cables, 3,730 feet long, and 4,500 feet were laid on that day from the Brooklyn anchorage to the first tower, and then discontinued till September 19. These cables are made in four sections, two sections of 1,015 feet each, and two sections of 850 feet each, so that they can be laid conveniently from the towers to the centre of the big span and spliced together in the centre. The ends are then carried around the towers and spliced to the sections running from the towers to the anchorages. These cables consist of 169 No. 18 wires twisted in pairs and stranded. They are manufactured by the Norwich Insulated Wire Company, of 58 Cedar street, this city, whose factory is in Brooklyn. This company uses a special paper insulation saturated with an insulating compound after the paper is applied to the bare copper. In making the bridge installation the cables were brought from the Robertson Lead Incasing works, 131 Water street, Brooklyn, where the largest business in the world is done in lead encasing of wires and cables, to a point on the south roadway of the bridge. The ends of the cables were taken off the big reel on the truck, drawn under the railroad track on special bearings and fastened to a powerful iron grip bolted to the end of a cable. A strong rope is fastened to this grip and run to the centre of the bridge and carried to the roadway again under the railroad where two pairs of horses are hitched to the opposite end and the cable drawn to the centre of the bridge. Special creosoted cleats were laid on the iron girders, which are about seven feet apart. These cleats are eight inches wide, several feet long, and about four inches thick. Mr. G. C. Allen, an electrical engineer, had this work in charge, and had a gang of 12 men to assist him, who are all in the employ of the New York and New Jersey Telephone Company, who are doing the above work for the Metropolitan Telephone Company, this city. The cables are to connect the underground cable of the New York and New Jersey Telephone Company's exchange in Brooklyn with the underground cables of the Metropolitan Exchange, 18 Cortlandt street, this city. Since writing this notice, Mr. Allen has completed the laying of the five cables.

Illumination in Brooklyn.—At the Thomas Jefferson Association reception, on Sept. 23, to David B. Hill, Governor of New York State, and Governor Abbett, of New Jersey, and Mayor Chapin, of Brooklyn, the new building of the Association, 5 and 7 Boerum place, was handsomely decorated on the front, from base to top. On the three arches on the face of the building were 174 incandescent lamps of 16 c.p. each. Across the front, in red, white and blue colored incandescent bulbs, were three stars and the letters "T. J. A.," and on the sills and lintels of the windows were large numbers of incandescent bulbs, and also lanterns holding incandescent lamps, there being a total of 495 lamps on the front of the building. The above three gentlemen were received by the Democracy of Brooklyn in the main hall, which contained 450 incandescent lamps in beautiful fixtures and chandeliers. In a dome of Mosaic glass in the centre of the hall were 250 incandescent lamps contained in rich electroliers and dome lights or small dome shades, making a very pretty effect. The whole building contains nearly 1,000 incandescent lamps. The construction of this work was done by the Tucker Electrical Construction Company, 14 to 20 Whitehall street, New York. In the work of insulation the company used 20,000 ft. of Grimshaw white core wire, Nos. 12 to 14, and 20,000 ft. of interior conduit. The conduits were run double to every outlet, or, in other words, a single wire was run in every conduit. The object was to give the very best results, and not in any way allow a possibility of a cross. The Tucker Company feel very proud of this work, and with good reason they may. The engineers of this company have installed in the new Germania Club Building, Schermerhorn street, Brooklyn 855 lights and several thousand feet of interior conduit. Grimshaw white core wire was used throughout the work. The ball room of this club is set off in the newest designs of electroliers and drop shades containing incandescent bulbs. The lighting effects here are very striking. On the faces of the gallery are neat floral fixtures that give very pretty effects in the diffusion of light, and throughout the building the best mode of disposition of the lamps to give the greatest diffusion of light seems to have been carried out. This company is also installing 1,000 lamps in the Germania Bank on Fulton street, using Grimshaw white core wire and interior tubing throughout the work.

W. T. H.

NEW ENGLAND NOTES.

Branch Office of The Electrical World,
Room 8, Cook Building, cor. Franklin and Congress Sts.
Boston, Sept. 27, 1890.

Will Put in a Plant.—The town of Reading, Mass., has appointed a committee to estimate the cost of erecting and maintaining electric lights.

The Standard Electric Company, of Vermont, installed a 100 light plant for the Evans Artificial Leather Company, Salem, N. H., this week.

Dividend.—The Thomson-Houston International Electric Company announces a dividend of $3.50 per share to the preferred stockholders of record Oct. 1, payable Oct. 15.

Mr. O. G. Platt, of Bridgeport, Conn., is exhibiting a beautiful case of his celebrated New England switches and other electrical appliances at the St. Louis electrical exhibition.

The Bridgeport (Conn.) Machine Tool Works are installing a 360-light Edison dynamo for lighting their factory, and will use the Evans system of driving to economize in room.

A Large Pay Roll.—There were 2,550 names on the pay-roll of the Thomson-Houston Electric Company's factory, at Lynn, Mass., on the last pay day, and it is said that the number is increasing all the time.

Mr. H. E. Swift has assigned his new socket for incandescent electric lamps to the H. E. Swift Manufacturing Company. This company is doing a good business, and now employs over 50 people, working on electrical novelties.

Mr. W. G. Bishop, of New Haven, is making an exceptionally good plating machine which he has found to be in good demand. He is also selling a great many castings and material for experimental dynamo work to beginners.

Mr. Chas. Worth Cartwright, of the Consolidated Electric Company, will be united in marriage to Miss Lottie J., daughter of Mr. and Mrs. Silas T. McKenney, at St. Ann's Episcopal Church, Dorchester, Mass., Wednesday evening, Oct. 8.

Mr. C. D. Smith, of the National Carbon Company, of Cleveland, has been hustling through Connecticut this week, testing the "nutmegs" and oysters. As usual, he reports that the "people" are still crying for his carbons, and that there are only a few more left.

The Pettingell-Andrews Company has secured the exclusive agency for New England and Eastern Canada for the sale of the Universal Arc Lamp Company's new lamp for use on incandescent circuits. This lamp is doing excellent work, and the very best results have already been shown. It is furnished at any desired voltage, and is sure to be very popular.

Fire in the Thomson-Houston Foundry.—The old foundry on Water street, Neponset, Mass., recently purchased by the Thomson-Houston Electric Company, and occupied by that concern as a foundry and repair shop, took fire from some unknown cause last week and before the blaze could be extinguished had damaged the building and its contents to the extent of $15,000.

Hartford, Conn.—The Hartford Light and Power Company has now in the factory of Pratt & Whitney 78 arc and 250 incandescent lights, quite an electric station in itself. In addition to this it has lately installed 150 incandescents in the new factory of the John Pratt Company, and is now installing a large number of arcs and incandescents in the new foundry that Pratt & Cady are building.

Mr. Nelson W. Twiss, of New Haven, Conn., is about ready to show to the trade a new type of four-valved engine, in which there are about one-third less parts than in the ordinary Corliss engine. It is promised that it will be equal or superior to these in simplicity and durability, and will effect a saving of about 20 per cent. in the first cost. This engine will be especially useful for electric light plants.

Mr. E. A. Fitzgerald, superintendent of the Meriden (Conn.) Electric Light Company since its inception and for years identified with electrical affairs, has been appointed inspector of electrical risks for the State of New York, outside of the metropolitan districts, by the New York Board of Fire Underwriters. Mr. Fitzgerald has a host of friends who extend their congratulations. The New York board has secured a valuable assistant.

The Tropical American Telephone Company has lately placed on the market a new long distance telephone set which is meeting with a very large sale. Business to foreign countries is increasing very rapidly. A large consignment of magneto call bells of all styles and switchboards of both Williams and Standard styles have just been received. The company announces that it is now prepared to furnish export orders at short notice.

Orders for the Sorley Battery.—The Eastern Electric Light and Storage Battery Company, of Lowell, Mass., has supplied the Sorley storage battery for lighting the Lawrence Mills, White Bros.

& Co., Lowell Bleachery, Traders' and Mechanics' Insurance Company, Lowell; J. M. Sears' private residence, Southbridge; F. L. Ames' residence, North Easton, and has several orders on hand including orders for installing batteries in Abbot Academy, Andover; Howland Mills Manufacturing Company, New Bedford, etc.

L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
31 CITY BUILDING, PHILADELPHIA, Sept. 27, 1890.

Alfred F. Moore is pushing the work on the large additions to his cord and cable factory at 202 North Third street, in this city.

Messrs. Alexander Bros. have just completed over 200 feet of their 36-inch double leather belting for the new Jenkintown electric light plant.

Slight Fire.—A fire from an unknown origin occurred in the Murray Flint Glass Works, Trenton and Allegheny avenues, last Wednesday morning. The loss was but slight.

Mr. A. A. Guigues, North Third street, has purchased a 300-light dynamo of Messrs. Walker & Kepler. This dynamo will usually be run from the shafting. In order to furnish a few lights at night he has purchased from Messrs. M. R. Muckle, Jr., & Co. a 15 h. p. standard Westinghouse engine, which will be used for this purpose when the main power is shut down.

Sale of Engines.—Messrs. M. R. Muckle, Jr., & Co. sold to Messrs. Wm. Wood & Co., of Spring Garden street, two months ago, two 100 h. p. compound Westinghouse engines, and one 15 h. p. Junior Westinghouse engine, for their electric light plant. They have followed this up by the sale to the same parties of a 16×27×16 compound Westinghouse engine of 200 h. p. to drive the new mill now being built.

Messrs. G. H. Barnett & Co., proprietors of the Black Diamond File Works, have purchased a 100 h. p. Standard Westinghouse engine, to drive their new shops, of Messrs. M. R. Muckle, Jr., & Co., who are also wiring their building for 200 lights. They have moved their dynamo into the new shop, where it is driven directly from the end of the engine shaft by one of the Moore & White Company's friction clutches.

Messrs. Carl Hering and Richard W. Davids have established themselves at 308 Walnut street, Philadelphia, Pa., as consulting electrical engineers, making a specialty of testing, such as that of dynamos, motors and batteries; examinations and reports of inventions, expert opinions and testimony in patent causes, and the calibration of instruments. These gentlemen confine themselves to technical work as distinguished from contracting, but draw plans and specifications for and will supervise the erection of any electrical work.

Electrical Privileges.—At the meeting of the Electrical Committee of Council Sept. 18, the following bills were acted on: An ordinance granting permission to the Western Union Telegraph Company to open streets and lay and maintain cables and wires on Chestnut street, between Thirteenth and Fifteenth streets, and Broad street, from Sansom street to South Penn square, which was referred to a sub-committee of five. The ordinance granting permission to the Kensington Electric Light and Power Company to lay conduits and erect poles on all streets bounded by Sixth street, the Delaware River, Brown street and Columbia avenue was referred to the Board of Supervisors. An ordinance granting the same privileges to the West End Electric Light and Power Company was referred to a committee of five, the territory asked for being in the northern portion of the city.

W. F. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Sept. 27, 1890.

Mr. Charles D. Jenney, of Indianapolis, was a welcome visitor in Chicago last week.

Mr. W. J. Floyd, formerly with the Excelsior Electric Company, is now representing the Sperry Electric Company as city salesman in Chicago.

Mr. C. O. Harris, secretary of the Dallas Electrical Society, Dallas, Tex., is a welcome visitor in Chicago this week returning from the various conventions which he has attended.

The Consolidated Electric Company has been incorporated in Chicago to manufacture and sell storage batteries; capital stock, $300,000. Incorporators, Harry Lampert, L. B. Langworthy and E. J. Dahurs.

The River Forest Water, Gas and Electric Light Company has been incorporated at River Forest, Ill., to furnish water, gas and electric light; capital stock, $15,000; incorporators, H. E. Broughton, Frank C. Smith, H. Stuible.

J. E. Moore, who installed the Sprague electric railway system in Milwaukee and the Westinghouse electric railway system in Lansing, Mich., has returned to Purdue University to complete an extended course in electrical engineering.

The Elliott Electric Company has been incorporated at Chicago to manufacture and operate all kinds of appliances relating to electric railways. The capital stock is $100,000. The incorporators are M. W. Elliott, Francis W. Parker and C. P. Chapman.

The Northwest Chicago Electric Street Railway Company has been incorporated at Chicago to construct and maintain a street railway with a capital stock of $200,000. The incorporators are William Boldenweck, Patrick K. Maginnis and George Lil.

The Columbian Exhibition and Transit Company, to exhibit motors for street railway propulsion, establish street railway lines, trams, etc., has been incorporated in Chicago with a capital stock of $100,000; incorporators, B. J. McMahon, E. V. Hitch and H. C. Caulkins.

Alton, Ill.—Messrs. Rodgers and Donnavan, representing the Holmes street railway syndicate, have secured an option on the two street railroads between Alton and Upper Alton. If they conclude to purchase they will also build a road to North Alton, and operate all three by electricity.

Victoria, B. C.—The National Electric Tramway Company has just completed a line from Victoria to Esquimalt, the British naval station, a distance of four miles. Cars will run over the line about Oct. 5. The company is also putting in a 350 h. p. compound Corliss type engine, and is erecting a new car-house to hold 20 cars.

Pierre, S. D.—A deal was made last week by which the Pierre street railway, electric light plant, gas works, water-works, and other enterprises were all consolidated under the control of one company. The sum represented in the transfer, about $4,000,000, is furnished by St. Paul, Philadelphia and New York capitalists.

Mr. George B. Shaw, the general manager of the National Electric Manufacturing Company, Eau Claire, Wis., was in the city last week on a flying business trip. One of the western magazines recently illustrated the leading industries in Eau Claire, including the National company, and referred to the rapid growth of its business and to the fact that the National apparatus is now in operation in almost every State in the Union and is giving the best of satisfaction.

Comfort in Traveling.—The delegates returning from Minneapolis over the line of the Chicago, Milwaukee & St. Paul Railways speak in high terms of the excellent service shown in every department, and especially of the comfort of having an incandescent lamp in the berth, enabling them to read as late as desired.

Julius Andrae, Milwaukee, Wis., has secured the contract for delivering and installing complete a 100 light incandescent plant in the tannery of Geo. Martin, Jr., and a similar plant in the tannery of the H. Zoehriant Leather Company, and also to wire and install 172 incandescent lamps at Pfister & Vogel Leather Company's warehouse.

Mr. F. E. Calkins, the Chicago representative of the Rockford Electric Manufacturing Company, has secured the contract for installing 75 h. p. in stationary Mayo motors in the Chicago *Tribune* building, which order, taken in connection with the 65 h. p. in Mayo motors sold to the *Inter-Ocean* company, puts Mr. Calkins in the lead as a live, energetic agent.

The "D. D." Electric Motor Company, 327 St. Peter street, St. Paul, Minn., has several of its motors in service in St. Paul, and has booked orders for sizes ranging from ¼ h. p. to 10 h. p. They are also manufacturing a handsome toy motor to be operated with a battery, and have received orders for 500 each from two houses, while the prospects are that they will probably sell 5,000 before the holiday trade opens.

Mr. William Hood, the general western agent of the Accumulator Company of New York and the Electro-Dynamic Company of Philadelphia, has secured the large store-room, No. 239 La Salle street, in the Grand Pacific Hotel, and will immediately arrange to carry a complete line of all the supplies required in storage battery work and all the specialties manufactured by the Electro-Dynamic Company. Users of storage batteries can then secure needed supplies on very short notice.

Mr. S. S. Leonard, manager of the Western department of the Hill Clutch Works, has secured the contract for equipping the Kansas City Gas Light and Coke Company's new plant; the El Paso Electric Company, Colorado Springs, Colo.; the Englewood Electric Light Company, Chicago, and the Chicago Arc Light and Power Company's plant, which is to be wholly remodeled. Mr. Leonard has also secured several small contracts, and has kept his factory running overtime for some months.

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	61@ 62	Wisconsin	117@ 118
Michigan	97@ 99	Bell of Missouri	155@ 160
Great Southern	32@ 35	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$104@$105	Chicago Edison Co	$130@$132

The Carbon Trade.—The carbon men appear to have congregated in Chicago last week, not through any prearranged plan, but simply by accident. Mr. J. B. Crouse, of the Standard Carbon Company, of Cleveland, called on his many friends. Then General Manager Booker, of the Fidelity Carbon Manufacturing Company, of St. Louis, dropped in, and referring to the much-talked-about carbon trust, said that there was nothing in it; that the Fidelity had consolidated with the National in order that the latter company could supply its trade with a superior line of carbon specialties. Later, Mr. Webb C. Hayes, of the National Carbon Company, Cleveland, O., called on the prominent companies and secured orders for the winter's supply of carbons and additional data for his valuable little directory of arc light stations. It is a matter of regret that every company operating an arc light plant does not furnish its correct title and the capacity of its machines for entry in a book that is so convenient for reference. It requires but a postal card and a moment's time and ought to be attended to.

F. DE L.

SOUTHERN NOTES.

NORFOLK, Va., Sept. 27, 1890.

The New City Hall at Richmond, Va., will contain 14 miles of electric wires.

Belton, Tex.—The Belton Electric Light Company is putting in an additional dynamo.

Stanley, Va.—An electric light plant will be established. The Mayor can give particulars.

Petersburg, Va.—Thomas Pannell is getting estimates on the cost of an electric light plant.

Culpeper, Va.—A telephone line is being put up between Culpeper and Madison Court House, Va.

Wilson, N. C.—The National Electric Company, of Eau Claire, Wis., is putting up an electric light plant.

Comanche, Tex.—J. F. McCarthy and others are organizing a company to establish an electric light plant.

Houston, Tex.—The capital stock of the Citizens' Electric Light and Power Company has been increased $50,000.

Montgomery, Ala.—The city council has under consideration the establishment of a system of police signal telegraph.

Covington, Ky.—The capital stock of the Citizens' Electric Light and Power Company has been increased to $100,000.

Titusville, Fla.—Local capitalists are organizing a company with $10,000 capital stock to establish an electric light plant.

Athens, Ga.—The Princeton Manufacturing Company intends purchasing a dynamo to furnish its factory with electric light.

Atlanta, Ga.—The board of police commissioners has adopted the Gamewell police signal system. The plant will cost $11,000.

Opelika, Ala.—The Savannah & Western Railway Company is establishing an electric light plant to put lights at street crossings.

Burlington, N. C.—Messrs. R. L. & J. H. Holt contemplate the purchase of an isolated incandescent plant for their cotton mills.

Union City, Tenn.—J. E. Beck and others are endeavoring to organize a company for the purpose of establishing an electric light plant.

Spartanburg, S. C.—The Spartanburg Gas, Electric Light and Power Company contemplate the increase of their capital stock to $75,000.

Houston, Tex.—The Bayou City Street Railway Company has perfected arrangements for the adoption of electricity as its motive power.

Chattanooga, Tenn.—The Telegraph Pin Works of E. G. Willingham are to be considerably enlarged, the factory being behind its orders.

Wheeling, W. Va.—A new building will be erected by the Wheeling Electrical Company for the purpose of doubling the capacity of its electric plant.

Texarkana, Ark.—The Texarkana Steel Railway Company are preparing to change their line to an electric road and will expend $40,000 in making the change.

Bristol, Tenn.—An electrical railway is contemplated by the Southwest Bristol Land Company to run between that company's property and the city of Bristol.

Oakland, Md.—A $7,000 stock company has been organized by S. T. Jones, J. L. McComas, E. H. Sincell and others, to establish an electric light and power plant.

Yazoo, Miss.—The Thomson-Houston Electric Company, of Boston, Mass., have been awarded a contract for the erection of an electric light plant to cost $60,000.

Lawrenceville, Va.—A development company has been organized by E. B. Lewis and others, for the purpose, among other things, of establishing an electric light plant.

Galveston, Texas.—The Rapid Transit has been organized to build an electrical railroad. Seabrook W. Snyder is president, E. Porter secretary, and T. A. Gary treasurer.

The Mule Must Go.—The stockholders of the Atlanta Street Railway Company, of Atlanta, Ga., have determined to substitute electricity for the mule as their motive power.

La Grange, Ga.—The city council is discussing the question of issuing $50,000 of bonds for the purpose of establishing an electric light plant. The mayor can furnish information.

Memphis, Tenn.—It is stated that the City Council will accept the offer made by the Memphis Electric Railway Company to pay the city $20,000 for the privilege of extending its railway

Charlotte, N. C.—Another effort is being made on the part of Northern capitalists to acquire control of the Charlotte street railway, with the view of converting that property into an electric line.

New Orleans, La.—The New Orleans & Carrollton Railroad Company has recently applied to the City Council for privilege to run overhead wires on St. Charles avenue for an electric railway.

Lynchburg, Va.—On Monday night last a fire was discovered in the battery room of the Western Union Telegraph office, and spread so rapidly that the building and its contents were soon destroyed.

Bedford City, Va.—The Bedford City Electric Company put its new incandescent electric light system in operation on the 1st inst. and is supplying lights to many dwellings, offices and business houses.

Wilmington, N. C.—A syndicate is endeavoring to purchase the Wilmington street railway, and, if successful, will make it an electric road, and will extend the line to Wrightsville Beach, nine miles distant.

Montgomery, Ala.—The Ball Light and Power Company has been incorporated by P. B. Bibb, W. H. Gesner, A. B. Abercrombie and others, who propose establishing an electric light and power plant in that city.

Augusta, Ga.—The electric railway is completed. It has 26 miles of city tracks and 48 cars. The last of the rolling stock was received last week This is said to be one of the best equipped electric lines in the South.

St. Augustine, Fla.—The Electric Belt Line Railway Company is the name of a company being organized by H. Canfield, C. D. Blauvelt, George Old, and others, to construct an electric railway about five miles long.

New Orleans, La.—The city council has signified its willingness to grant a franchise to the Consumers' Electric Light Company recently reported incorporated, providing this company will agree to pay a tax of $5 on each pole erected.

Waynesboro, Ga.—A. G. Whitehead, P. L. Corker and others have incorporated the Waynesboro Electric Light Company with a capital stock of $7,500. Steps will be taken at once looking to the purchase of the necessary equipment.

Savannah, Ga.—Mr. W. A. Larey, of Charleston, S. C., who has been connected with the Postal Telegraph Company since the advent of that company in Charleston, has been made chief of the Savannah office of the Postal Telegraph Company.

Richmond, Va.—A resolution was offered at a recent meeting of the City Council, authorizing the committee on electric lights to advertise for bids for furnishing the city with electric lights, for twelve months or a shorter period, from Feb. 8, 1891.

Anderson, S. C.—The new electric light plant has been completed and the lights were turned on for the first time one night last week. Anderson has known nothing of gas. The transition in her street illumination was made from oil lamps to electricity.

Richmond, Va—The Waddell Railway Electric Signal Company has been organized and the following officers elected: S. H. Fletcher, of Lexington, president; O. C. Owens, vice-president; B. C. Wherry, secretary. The new company is now placing its capital stock.

Baltimore, Md.—The Underground Electric Traction Company, with a capital stock of $100,000, has been incorporated by J. J. Husband, F. L. Morling, J. J. Meyer and others, to build and operate an electric street railway by means of underground rails, conductors and trucks.

Charleston, S. C.—At a recent meeting of the city council a petition was presented by the Charleston Electric Light and Power Company, asking for permission to erect a plant on the corner of Marsh and Concord streets. The present quarters of the company are found to be too small.

Washington, Ga.—This town will soon be lit up with electricity. The money has been subscribed and the machinery for the plant ordered and shipped. The Cotton Seed Oil Mill Company obtained the plant, and have made arrangements with the city to light the streets and to furnish lights to many private houses.

Asheville, N. C.—A contract has been awarded by the People's Light, Heat and Power Company to L. N. Cox, of Washington City, and G. B. Shaw, of Eau Claire, Wis., for the construction and equipment of an electric light, heat and power plant to cost $40,000. Work on the new plant has been commenced and will be completed by Oct. 1.

Memphis, Tenn.—The Citizens' Street Railway Company announces its intention to convert the street railway into an electric line, and it is stated that bonds have been issued and placed with the Union Trust Company of St. Louis, Mo., for $2,500,000 to enable the company to carry out the contemplated programme of improvements.

Nashville, Tenn.—The United Electric Company declined to accede to the proposition of the Citizens' Rapid Transit Company looking to the use of the former's wires and track on Cedar street by the last named company. The amount the latter road ought to pay for this privilege was, in the opinion of the Board of Public Works, $3,214.04.

Nashville, Tenn.—The Capital Electric Company is putting a large motor in the Presbyterian Publishing House for the purpose of running its large presses. The Capital Company has been very busy the past summer putting in electric plants and elevator equipments. Among the electrical novelties the company intends introducing soon is an electric boot-blacking apparatus, with a nickel slot.

Weatherford, Tex.—Negotiations are reported pending between the Corsicana Ice and Refrigerator Company, of Corsicana, Tex., and the Weatherford Water, Light and Ice Company looking to the first named corporation purchasing the business and plant of the latter company. In the event of the transfer, the property will be considerably improved, the capacity increased, and new machinery added.

Anderson, S. C.—The Western Carolina Land and Improvement Company has been organized, with a capital of $300,000, to build a town 36 miles from Anderson, from which point an electric railroad will be built at once. The town will be named Calhoun for Mr. Patrick Calhoun, of Atlanta, Ga., who is largely interested in the enterprise. The company's charter also provides for the establishment of an electric light plant.

Atlanta, Ga.—The new electric line between Atlanta and Fort McPherson is now an assured fact. The capital stock of the company is $75,000. Grading has begun, and negotiations are now in progress with electrical construction companies for the building of the road. It is possible that a storage battery system will be adopted, and the road is promised to be first-class in every particular, equipped with the finest rolling stock procurable and every convenience provided for the comfort of patrons.

Nashville, Tenn.—The Electric Street Railway Company is still extending its lines. Work is progressing on the new line to West Nashville. Cars have been running to Mount Olivet Cemetery for some weeks. That there is growing confidence in the efficiency of the electric system is attested by the fact that the dummy lines have determined to use that motive power in place of steam, and steps have already been taken to make the change. The new cars will have double motors.

Macon, Ga.—When the Macon Horse Street Railway was purchased by a Philadelphia capitalist, George F. Work, and was about to be changed into an electric line, that gentleman was granted by the city council an exclusive right to operate an electric line on certain streets for the term of 20 years. New companies have recently been organized for the purpose of establishing electric lines, and they propose to test in the courts the constitutionality of Mr. Work's franchise. A lively war is anticipated.

Wheeling, W. Va.—The electric light plant of the Riverside Iron Company is nearing completion. It is composed of two Westinghouse dynamos of 50 arc lights each and one incandescent light dynamo The incandescent lights will be used in the offices and laboratories of the company, while the arc lights will be used in the yards, in the foundries and large open spaces. This plant is said to be one of the most complete ever constructed by the Westinghouse people, and covers as much ground as many municipal plants.

Sumter, S. C.—The first annual meeting of the stockholders of the Sumter Electric Light Company was held a few days ago. The exhibit made of the company's business was satisfactory to the stockholders, though the company is still in debt for the plant. Their capital stock was only $10,000, while their plant cost $17,500. It has been running ten and a half months at an expense of about $3,500. The gross income for lights was a little less than $4,700, making a net income of about $2,000 after paying interest on borrowed money. The company intends doubling its capital stock shortly, and will increase the capacity of its plant and pay off the indebtedness.

Richmond, Va.—The Committee on Electric Lights of the City Council met on the 24th inst., to consider the resolution introduced recently appropriating $75,000 for the establishment of an electric light plant. The committee very promptly and unanimously decided to recommend the adoption of the resolution. At a later hour the above committee met with the Financial Committee in joint session, and the question was discussed at length. Messrs. Courtney, Adams, Mann, Cary, Christian, Bowden and Glover were appointed a select committee to procure plans and specifications and to make further inquiry as to what the plant would cost, and at what price the lights can be furnished. The result of this investigation will be reported to a future meeting of the two committees.

Atlanta, Ga.—Messrs. H. M. Atkinson, J. H. Porter, John L. Hopkins, W. A. Hemphill, J. W. Rucker, John Ryan, J. L. Langston and Walter H. Rhett have incorporated the Atlanta Electric Illuminating Company for the purpose of manufacturing and selling machinery, articles, apparatus and devices of every kind pertaining to the use or application of electricity for light, heat, power, transportation and such other uses as it may be employed in or applied to. The capital stock of the company is $100,000, with the privilege to increase same to $1,000,000. Immediately upon the organization of this company steps will be taken looking to the early establishment of a large electric plant that will have capacity to furnish light, heat and power. Among the ultimate intentions of the company is the construction of an electric railway.

An Economical Police Alarm System.—At Pensacola, Fla., at a cost of only $70, police calls may be sounded at any time over wires that extend to every part of the city. The fire alarm system is utilized in doing this. The superintendent of the fire department is also superintendent of the fire alarm system. He says he has found no difficulty whatever in adapting the fire alarm system to the needs of the police, and as a result his city has, at no additional expense worth mentioning, a perfect fire alarm and police call system. The wires are primarily connected with police headquarters, where the nature of an alarm is first determined. Three or four strokes will tell whether the patrol wagon or the hose truck be wanted. If the latter the alarm is at once switched on to the truck house and action is taken by the firemen accordingly. If the former, the alarm never reaches the truck house, and there is consequently never an unnecessary fire alarm. Y. N. B.

ENGLISH NOTES.

(*From our own Correspondent.*)

London, Sept. 17, 1890.

The Meeting of the British Association at Leeds.—The following sketch of the recent meeting of the British Association at Leeds, which I send in addition to my brief cablegram, may be of interest to some of your readers. As I stated in my telegraphic message, the electrical papers read in section G, which is devoted to practical applications of science, were not remarkable either for their number or their novelty. Mr. Barber Starkey had a short paper on secondary batteries, in which he stated that a lengthened experience of his device of adding carbonate of soda to the solution for the purpose of preventing sulphating had confirmed him in his original opinion of the value of the process. Mr. Gisbert Kapp described the oft described Lineff system of electric traction, and the discussion which followed showed that this system had already gained several adherents. Indeed it seems to be an ideal system for English requirements. Mr. Newman Lawrence and Dr. Harries read a paper on "Alternate and Continuous Currents in Relation to the Human Body," which was merely an amplification of their paper recently read before the Institution of Electrical Engineers. Sir William Thomson exhibited several interesting instruments, among which was an electric meter, the general principles of which may be described as that in which a sample of the current is taken at regular intervals and measured on a counter train, the measurement being effected on the "Weber dynamometer" principle. The instrument as presented was not in its final shape and a more detailed description will shortly be forthcoming. In answer to some remarks as to the expensive form of the instrument, as it then stood, Sir William Thomson said that the reduction of expense was the life and soul of engineering. Economy must always be considered, except in the building of ironclads and in the work of section A, where everything should be done regardless of expense. His endeavor was to make first the most perfect instrument possible, and after it was completed to make it economical. Another instrument which Sir William Thomson exhibited was a new form of volta pile useful for standardizing operations. Four hundred staples, constructed with one limb of copper and the other of zinc, are mounted in an ebonite frame, standing on four wooden legs. The adjacent staples are set at a distance less than 1-20 inch apart, their ends pointing downward. A copper tray, with handles, is placed below the frame, and contains water. On lifting the tray, so that the ends of the staples are immersed, and lowering it again, a drop of water is left hanging by capillary attraction between the zinc and the copper of the adjacent couples. The whole thus forms a simple battery of 400 cells. The battery is not made for giving a current, but is used with an electrometer, and saves a great deal of trouble and expense compared with the setting up of a number of ordinary batteries. It has been found to to be particularly useful in measuring the capacity of cables.

Mr. Preece also had a short paper "On the Form of Submarine Cables for Long Distance Telephony," in which he stated that the telephonic cable across the channel which is to connect the French and English ends of the London-Paris telephone line would be a four wire cable. The product of the capacity into the resistance of the circuit, upon which clearness of articulation depends, is estimated at 5,900, indicating that speech should be excellent.

In section A some 30 electrical papers and a batch of reports were read, comprising contributions from Sir Wm. Thomson, Prof. G. F. Fitzgerald, Prof. Oliver Lodge, Prof. J. A. Ewing, Mr. R. T. Glazebrook, Mr. W. H. Preece, Mr. James Swinburne, etc. These were for the most part of an abstruse character. Mr. R. T. Glazebrook's paper on "Recent Determinations of the Absolute Resistance of Mercury," and that of Prof. V. Jones on "Suggestions toward the Determination of the Ohm," led to a long and interesting discussion on the subject of electrical units, in which Sir Wm. Thomson, Lord Rayleigh, Prof. Rowland and others took part. The outcome of the discussion was, as I mentioned in my cablegram, the adoption by the British Association of a mercury column, 1 square millimetre in section and 106.3 centimetres long, as representing the true ohm (109 C. G. S. units). This proposal was supported by Mr. Preece, who explained at great length the reasons which induced him to advise the British Government not to adopt the length of 106 centimetres proposed provisionally in 1884. Professors Rowland and Mascuart undertook on their part to recommend the adoption of this standard by their respective governments. The various ohms now wandering about will, at last, it may be anticipated, have to give way to the "true ohm."

Mr. Preece had an interesting paper "On the Character of Steel Used for Permanent Magnets," in which he supported by an array of laborious experiments the statement which he recently made at the Institution of Electrical Engineers, to the effect that English steel was decidedly inferior to French steel for the purpose of making permanent magnets. His experiments show that the value of the magnetic induction in the case of French steel is from 40 to 50 per cent. higher than that which can be obtained in the best English samples. As to the retentiveness of the French magnet steel, Mr. Preece has as yet but little to say, though this, of course, is of more importance, so far, at least, as the post office is concerned, than the question of maximum induction. In the course of the discussion that followed the reading of the paper, Sir Wm. Thomson said he was of opinion that there was a large future open to permanent steel magnets for dynamos, since so many brands of steel were now in the market whose retentiveness and permeability were great.

The most important communication at the Leeds meeting was undoubtedly that of Professor Ewing, whose "Molecular Theory of Induced Magnetism" evoked congratulations and expressions of admiration from every one who had the privilege of listening to his lucid discourse and inspecting his ingenious model. It was considered by many as ranking with Hertz's discovery of electrical oscillations. It would be impossible to give within the limits of a letter even an abstract of Professor Ewing's theory, which, I may mention, is now being published in the technical journals. Briefly, Professor Ewing shows that by simply looking to the magnetic forces which molecular magnets exert upon one another, we are able to explain, without the addition of any arbitrary assumptions, the whole range of magnetic phenomena, such as residual magnetism, hysteresis, the variation of magnetic permeability under variations of stress, the variation of permeability with variations of temperature and the effects of vibration.

News of the Week.

THE TELEGRAPH.

Fairhaven, Wash.—The Fairhaven District Telegraph and Messenger Company has been formed to build telegraph lines in Whatcom, Sehome and Fairhaven. The capital stock is $10,000.

Seattle, Wash.—The Puget Sound Telegraph Company has filed supplemental articles of incorporation, extending the existence of the corporation 25 years, to enable it to carry out the project of leasing the line to the Pacific Postal Company for 20 years.

THE TELEPHONE.

Mr. D. J. Matlock, formerly of Los Angeles, has been appointed manager of the Sunset Telephone office at San Jose. A number of improvements will be made in the service, including new switchboard, annunciators, etc.

The Christy Telephone Company has been organized in San Francisco, Cal., for the purpose of conducting a general telephone and messenger business in the State of California. The capital stock is $1,000,000, of which $800,000 has been subscribed. The following are the directors: Ferdinand A. Haber, Charles M. Oakley, James A. Christy, F. E. Wait and Thomas W. Cosgrove.

Monthly Output of Instruments.—The Bell Telephone Company makes the following instrument statement for the month ended Sept. 20, and nine months to date :

September—	1890.	1889.	Inc.
Shipments	5,723	4,602	1,121
Returned	2,358	1,975	383
Net output	3,365	2,627	738
Since Dec. 30—	1889-90.	1889-90.	
Shipments	48,4 9	43,242	5,167
Returned	20,110	18,117	1,993
Net output	23,299	25,125	3,174
Instruments in use Sept. 30	473,160	436,666	36,494

THE ELECTRIC LIGHT.

Tacoma, Wash.—The Excelsior Park Land Company has been formed to erect electric light plants, street railroads, etc.

A Month's Business.—The August sales of the Westinghouse Electric Manufacturing Company are said to have been $400,000.

New Company Organized.—A charter has been drawn at Mansfield Valley, Pa., for a new electric light company for the twin boroughs. It is said that one-half of the capital will be taken by Pittsburghers.

Articles of Incorporation were filed last week at the Massachusetts State House by the Ware Electric Light Company for furnishing light, heat and power in Ware and Hardwick, Mass., with a capital of $20,000. F. D. Sitley is president and F. D. Gilmore, treasurer.

Electric Light in Haddonfield, Pa.—The stockholders of the Haddonfield Electric Light and Power Company have elected the following officers: C. H. Mann, president; F. Sutton, treasurer; Walter S. Hunt, secretary; H. N. McKinney, B. H. Shivers, M. D.; E. H. Nye and A. R. Underdown.

An Electric Fountain.—One of the greatest attractions of the Pittsburgh Exposition is the electric fountain. It was designed by Mr. Ernest Gawthrop, a well-known electrician, who is a brother of Mr. E. B. Gawthrop of the firm of Hughes & Gawthrop, the Western Pennsylvania representatives of the Thomson-Houston Electric Company. The fountain has been pronounced a great success by General Manager Johnston of the Exposition, and by the public at large.

The Monongahela Electric Light Company, of Monongahela City, Pa., in order to hurry forward the installation of the incandescent light in private and business houses, has, as an inducement to an early decision on the part of prospective consumers, offered to contract to furnish the necessary labor and material for open or cleated wiring at a rate of $2 per lamp until the first of October. This price does not cover the cost of material and labor. It is the company's intention to meter all current used.

Santa Fe, N. M.—A company has been formed to give this city an electric light plant. E. T. Webber, of Denver, is at the head of the concern, and his associates are C. F. Fisher, T. B. Catron, J. J. Schumann and N. B. Laughton, of Santa Fe. They have organized with a paid-up capital of $25,000. Inside of 60 days they expect to have their plant in operation. Irving Hale, of Denver, representing the Edison system, and C. G. Davis, of Kansas City, agent for the Westinghouse system, are endeavoring to secure the contract of setting up the plant.

Edison Exhibit at Portland, Ore.—At the exposition now being held in Portland, Ore., a tower, very similar in construction and appearance to the one which was called the "Tower of Light" at the Lenox Lyceum in this city last spring, has been erected and lighted with Edison miniature lamps. This is set in a large bank of flowers. The tower and festoons contain about 3,000 lamps of four c. p. each. The tower was completed in time to be lighted on the opening night and was a great success, giving entire satisfaction to the management and winning much applause from the public.

A Successful Accumulator Plant.—Vice-President Morton's residence on Rhinecliff-on-Hudson is equipped with a plant of cells of the Accumulator Company's type. The engineer in charge, Mr. W. B. Philbrick, says that the plant has been in operation for over two years, and is in as good condition to-day, apparently, as when first installed. It has given no trouble whatever, outside of ordinary care, and has cost practically nothing for repairs. The lights have given entire satisfaction and the accumulators have never failed to furnish the required energy. He also says this system of lighting compares very favorably with gas in point of economy, and has the advantage of being free from smoke and heat, besides affording a most agreeable light. There is a large saving as compared with the cost of running the engine all the time in labor, fuel and wear and tear on the machinery Mr. Morton has found the system very satisfactory in every way.

Increased Business of the Westinghouse Company.—The business of the Westinghouse Electric and Manufacturing Company has received an extraordinary boom during the last month. The shops are now running at their full capacity day and night, and the company has still orders ahead to keep it busy the entire winter. This large increase in the work is especially caused by the wonderful success of the street car motor lately brought out. Several roads have been equipped already, and their operation has proved to give more than ordinary satisfaction. The manufacture of alternating current apparatus has also gained considerably, and the new Westinghouse system of alternating current arc lighting is rapidly becoming a popular method of illumination. Among the contracts the company has recently obtained are St. Paul, Minn., for an increase of apparatus to the extent of 3,000 incandescent lights capacity; Arlington Heights, Tex., 500 lights; Rochester, Pa., an increase of 500 lights, and Colorado Springs, Colo., an increase of 1,500 lights.

APPLICATIONS OF POWER.

Oakland, Cal.—J. W. Hartzell has applied to the Oakland Trustees for a franchise for an electric road.

Franchise Granted.—The Sacramento (Cal.) trustees have finally passed the ordinance granting permission to use the overhead electric system on the Central Street Railroad.

The Peninsula Electric Railway Company has been incorporated at Tacoma, Wash. The capital stock is $500,000. F. C. Todd, T. O. Abbott and A. S. Dantrick are the incorporators.

Suit Brought to Trial.—The suit of the Electric Improvement Company against the San Jose and Santa Clara (Cal.) Railway Company went to trial recently. The suit was brought to recover about $19,000, with interest from September, 1888.

Louisville, Ky.—The Edison General Electric Company has entered into a contract with the Louisville Railway Company for a large station equipment, including four No. 60 generators of 150,000 watts capacity each. It will be remembered that this road is now the property of the street railway syndicate which is operating

roads in Buffalo, Pittsburgh, Louisville, Newark, Rochester and elsewhere.

Franchise Granted Over the Mayor's Veto.—The Oakland (Cal.) City Council has passed over Mayor Glascock's veto the crosstown electric franchise of John W. Coleman, from the Bay at Sixteenth street depot to Twenty-third avenue, in East Oakland.

The Duquesne Traction Company is rapidly pushing the work on its electric line to Wilkinsburg, Pa. To get into that suburb, however, the Pennsylvania Railroad is to be crossed, and the only way to effect the crossing is to go underground. A tunnel is to be made and this will cause a little delay in the plans of the company, but the cars will be running, nevertheless, before snow flies.

From Natick, Mass., to Boston by Electricity.—The selectmen and the street railway company have adjusted matters satisfactorily to both parties, and the electric railway company will build a road from South Natick to Natick, which means connection with Boston by electricity, as Natick will soon extend the tracks through Wellesley and join with Newton, thus making a complete line to Boston.

The Short Electric Railway Company has received an order from the Rochester Railway Company for twenty-four motors of 25 h. p. each, to be placed on the snow sweepers now being constructed by the Lewis & Fowler Manufacturing Company, of Brooklyn, N. Y. These sweepers, six in number, will be heavier than any yet made by this company, and the motors are large and powerful. Two of them will be needed to operate the truck and one to run each broom, making four motors to each sweeper.

Street Railway for St. John, N. B.—The Edison Company is doing a large amount of foreign business, one of its recent contracts being for the equipment of the St. John City Railway Company, of St. John, N. B., which is one of the strongest roads in the Dominion. The contract was closed through Mr. John F. Zebley, of New York, the president of the road, and the Edison system was determined upon by Mr. Zebley after a most thorough and careful examination of the different railway systems in this country.

The Utica & Mohawk Railway Company, which recently contracted with the Edison Company for five cars and station equipment, has now been in operation for about three months, with most satisfactory results. Its picnic business has been very large, the road on some occasions carrying 10,000 passengers a day. The wisdom of President Mann's new departure has been thoroughly demonstrated. It is worthy of note that under Mr. Mann's management this road has become one of the best equipped and best paying properties in the State.

A large contract for station equipment has been made with the Edison General Electric Company by Thomas Lowry, president of the St. Paul & Minneapolis railway systems. It will be remembered that early in the year Mr. Lowry placed with the Edison Company the largest single contract for railway apparatus which has ever been given to a railway company, calling for over 7,000 h. p. of electrical apparatus. The contract just closed provides for 15 No. 60 Edison dynamos of 150,000 watts capacity each, and 20 cars for use between St. Paul and Minneapolis, the latter being required to make a speed of 25 miles per hour.

A Novel Use for the Electric Motor.—The convenience of the electric motor is being shown to crowds who watch the Sioux City Corn Palace, now in course of construction. About 15,000 bushels of corn are used to decorate the building. Last year the saws to split the corn were run by four horses, and the irregular speed caused much annoyance. This year a 3 h. p. Hawkeye electric motor belted direct to a saw does all the work much more satisfactorily, one man sawing about 60 bushels an hour, to supply over 200 men and about the same number of women, who are decorating the building. For working at night the immense structure is illuminated by 50 arc lights and over 1,000 incandescents.

MISCELLANEOUS NOTES.

The Los Angeles (Cal.) Construction Company has been organized to do a general business in electrical matters.

The Consolidated Electric Storage Company has designed a very handsome accumulator for phonograph work. It is placed in a hardwood box so as to be similar in style to the phonograph box. This box is water-tight, so that the accumulator may be shipped already charged without fear of spilling the solution. It is carried by a leather strap provided for the purpose. The capacity of the accumulator is from 200 to 300 ampère hours, and weighs, including the box, about 42 pounds.

Quotations on Electrical Stocks.—Mr. F. Z. Maguire, electrical securities, of 18 Wall street, this city, reports the following quotations of Saturday, Sept. 27, from New York, Boston, Washington and Pittsburgh:

NEW YORK.

	Bid.		Bid.
W. U. Tel. Co.	82½	Edison Gen. Elec. Co.	*90
American Tele. & Cable.	83	Edison Gen. Co. Def'd	85
Cent'l & So. Amer.	155	Consol'd Elec. Lt. Co.	60
Mexican	205	Edison Illn'g Co., N. Y.	70
Com. Cable Co.	.....	U. S. Elec. Lt. Co.	30
Postal Tel. Cable	39	North Am. Phon'gph.	...

BOSTON.

	Bid.		Bid.
Thomson-Houston	49	Ft. Wayne Co.	10¼
" Pref'd	25⅞	Am. Bell	226
" Series C.	....	Erie	48⅛
" " D.	6	New England	51
" Int. Co.	....	Mexican	.90
Thomson Welding Co.	200	Trop. American	.....
Thomson Eu. Welding	66	Edison Phon'gph Doll	2

WASHINGTON.

	Bid.		Bid.
Penna. Telephone	26	Eck. & Sold. Home Elec.	
Ches. & Pot. Telephone	73	Ry.	68¾
Amer. Graphophone	16⅛	Georget'wn & Tenallyt'n.	54
U. S. Electric Lt. (Wash.)	*155		

PITTSBURGH.

	Bid.
Westinghouse Electric Manufacturing Company	36

*Ex dividend.

Bids Submitted.—The Gamewell Fire Alarm Telegraph Company and the Municipal Signal Company have submitted bids to the commissioners for the erection of a police patrol telegraph and telephone system in the fifth and eighth police precincts of Baltimore, Md. The Gamewell Company offer to do the work at $5,175 in the fifth precinct and $4,650 in the eighth precinct, and the Municipal Company submits two plans for each precinct: $4,850 or $5,550 in the fifth precinct, and $3,250 or $3,500 in the eighth precinct. No award has been made.

Industrial and Trade Notes.

The Illinois Electric Material Company, The Rookery, Chicago, is sending out a handsome pocket price list of the patent woven wires and cables made by the American Circular Loom Company, and for which it is the Western agent.

Jenkins Brothers, manufacturers of valves and standard packing, whose office is at 71 John street, in this city, have embodied, in a catalogue recently issued, a great mass of information of use to the trade, concerning their safety valves, check valves, radiator valves and others of various kinds.

A Big Belt.—Chas. A. Schieren & Co. are running the main driving belt at the St. Louis Exposition. It is a leather link belt 81 feet long and 20 inches wide, and is the same belt that drove the whole American section at the late Paris Exposition. They have lately taken an order for two 30-inch double perforated belts and three 12-inch double perforated belts for the Pueblo (Col.) Street Railway Company.

The Fitchburg (Mass.) Machine Works are crowded with orders, so much so that they are obliged to figure very closely to fill them. Recent orders are from the Brush Electric Light Company, Cleveland, lathes of 30 and 42 inches, planers 36 inches, and numerous drills and shapers. The company is also doing a large amount of work for the Thomson-Houston Electric Company and the Thomson Welding Company.

A Souvenir.—The Illinois Electric Material Company, Chicago, will send to every electrician or official connected with electric light or railway plants sending his address a neat pocket pencil that will prove convenient at all times, and which will also remind the user that there is but one "Canvas Jacket" insulation in the market, an insulation that is being used more extensively as its high qualities are appreciated.

A unique switch, embodying many new features, will be brought out by the Great Western Electric Supply Company in about 10 days. It is said to work on a new principle, and a good thing is promised. The same firm is also getting a new fire-alarm system ready for the market. This is said to possess many advantages over the release key system now in general use, and will probably meet with favor in small towns.

The Electric Merchandise Company, Chicago, will be located in Parlor "F" at the Iroquois Hotel, Buffalo, during the week the American Street Railway Association meets in convention there. Mr. W. R. Mason, the general manager of the company, will be on hand to entertain the visitors and to show samples of the most complete line of street railway supplies in the country, and will be assisted by Mr. John Gustin, the purchasing agent of the company.

The Crosby Electric Company a short time since purchased all the patents of Charles Hussey, comprising some valuable open and closed circuit batteries, among which is the Duplex battery which has already commended itself to the trade and construction companies. The closed circuit batteries have stood severe tests and are in use to-day by thousands for all kinds of work, particularly for charging storage batteries. The company has also a bell battery and telephone battery and other specialties.

The Great Western Electric Supply Company.—A report was in circulation the past week that the Great Western Electric Supply Company was financially embarrassed. This, we are requested to state, is without substantial foundation. It may have arisen from the fact that the company, originally organized under the laws of Iowa, has recently been reorganized under the laws of Illinois and a controlling interest therein has been acquired by Mr. E. R. Gilman. Mr. George Cutter retains the post of manager and electrician.

Exhibit of Electrical Supplies.—Among the electrical attractions of the Chicago Exposition is the varied display of fixtures, telegraph instruments and house goods by the Great Western Electric Supply Company. A sign made of cleats and another made of colored shades are novel, and, like the elk-head electrolier which lights the exhibit, are much admired. The assortment of linemen's tools shown also seems to catch the eye of the electrical people who visit the Exposition. The same firm also has a display of its specialties at the St. Louis Exhibition, in charge of Mr. G. T. Hewes.

The New Haven Insulated Wire Company (Messrs. Hague & Bean, proprietors) is rapidly getting into shape into the new factory, corner Haven and Market streets. The building is 140 × 40, and of wood, with an addition of a new brick steam plant. It is lighted by a 100-light incandescent dynamo and more light will be added as required. This company is manufacturing insulated wires and cables for electric light, telephone and telegraph use of special abrasion and waterproof test. At present the capacity of the factory is 75 miles per week; but this will be at once increased to double the amount.

The Tripp Manufacturing Company, of Boston, has received some very flattering testimonials regarding its packing, some of the more noticeable ones being from Fred D. Hart, engineer Brooklyn Bridge; Thos. J. Lavory, chief engineer East Boston Ferries; Barbour Flax Spinning Company, Paterson, N. J.; Amoskeag Manufacturing Company, Manchester, N. H., etc. These testimonials show this packing in use for a number of years with very little wear and still in good condition. The new Tripp electric truck is also meeting with great success, no less than 15 electric railways having lately ordered them.

The Electric Merchandise Company, 11 Adams street, Chicago, is sending out a neat circular calling attention to its gears, pinions, bearings, etc., for all systems of electric railways. Referring to its special make of rawhide pinions, the circular says: "While the wear of these pinions has been alike surprising to us and to roads using them, we have been enabled, owing to a late discovery, to so far improve the manufacture that we believe that the pinions we are now ready to send out will last equal to those made of metal, besides adding largely to the life of the gears, and doing away entirely with the objectionable noise made by metal pinions."

The Standard Electric Company, of Vermont, through its New England manager, Mr. Ferrin, reports the following recent sales: One 500-light dynamo to Ashley & Bailey, Hudson, N. J.; one 300-light dynamo to National Needle Company, Springfield, Mass.; one 300-light dynamo to J. B. Van Seaver, Camden, N. J.; one 300-light dynamo to A. W. Sulloway, Hosiery Mills, Franklin Falls, N. H.; one 300-light dynamo to the Republican Press Association, Concord, N. H., the only building in New Hampshire devoted entirely to printing purposes; one 300-light to Cordis Cotton Mills, Millbury, Mass.; one 200-light to J. M. Sharpless & Co., Chester, Pa., and one 100-light to Winnipesaukee Paper Manufacturing Company, Franklin Falls, N. Y.

Webster's "Vacuum" exhaust steam economizer is meeting with great success among the electric light companies and electric street railways. The Conshohocken (Pa.) Electric Light Company has just started one in connection with its plant, and Mr. Cooper, the manager, reports that it is precipitating large quantities of sediment at the high temperature at which it feeds the pumped water to the boilers, and he is very much pleased with the results obtained from its use. The Union Depot Electric Railway Company, of St. Louis, also is so well pleased with the operation and results obtained from the 600 h. p. economizer which it ordered some few months ago that the company has just ordered another of 800 h. p. The manufacturers are Messrs. Warren Webster & Co., 491 North Third street, Philadelphia, Pa., with branch offices at 74 Cortlandt street, New York, and 159 La Salle street, Chicago.

Recent Contracts.—Among the recent railway contracts closed by the Edison General Electric Company may be mentioned the following: The Minneapolis Street Railway Company, of Minneapolis, Minn.; the Savannah Street & Rural Resort Company, of Savannah, Ga.; the Dallas Consolidated Traction Company, of Dallas, Tex.; St. John City Railway Company, of St. John, N. B.; James Street Belt Line Railway Company, of Seattle, Wash.; St. Paul City Railway Company, St. Paul, Minn.; Tacoma Railway & Motor Company, of Tacoma, Wash.; Richmond City Railway Company, Richmond, Va.; Utica & Mohawk Railway Company, of Utica, N. Y.; Elmira & Horseheads Railway Company, of Elmira, N. Y.; Elgin City Railway Company, of Elgin, Ill.; People's Street Railway Company, of Scranton, Pa.; Fort Scott Railway Company, Fort Scott, Kan.; Louisville Railway Company, Louisville, Ky.; Pittsburgh Railway Company, Pittsburgh, Pa.

The Consolidated Electric Storage Company, engaged in the manufacture of the Julien storage battery, solicits estimates for isolated lighting by storage batteries. This company has been giving considerable attention of late to this department, and it is understood has now, in convenient and printed form, estimates for 20, 30, 40, 50, 100 and 200-light plants. The estimates give the cost of installation, whether by gas, oil, or steam engine. They also give the cost of maintenance. The natural demand which should exist for isolated electric lighting has not been fully appreciated in the past. The reason probably is that it is only very lately that generating machinery especially adapted to that kind of work, and economical and reliable, has been perfected. Another cause, in all probability, is the uncertainty arising from legal controversies in relation to the storage battery, which has made customers timid about investing their money in plants of that kind.

Englund's Centre Curve Insulator.—The managers of the Electric Merchandise Company, Chicago, who are the owners of the patent for Englund's centre curve insulator, have during the last few years experimented very largely with a view of securing an insulator which, while being neat in appearance, would have the requisite strength needed for all demands, however great. Some objection has been raised to those heretofore made, on the ground that to get the needed strength it has been necessary to have the insulator so heavy that it has been unwieldy to handle and heavy in appearance on the line, while if attempts have been made to lighten it openings have had to be made which, filling with rain and snow, have destroyed the insulation. All these objections are said to be removed by this insulator. It is a solid but very neat coil of rubber of but nine inches in length, and when placed on the line is scarcely discernible. It is, however, protected on the inside of the rubber so securely that it is claimed that it will endure any strain which may be put upon it, even to holding the extreme ends of the line.

The Butler Hard Rubber Company, 33 Mercer street, this city, has secured all the valuable inventions of Mr. Wm. Kiel which are claimed to have radically changed all methods of making and vulcanizing hard rubber. The advantages claimed are a rich black throughout, which is said to be very durable, and to possess increased flexibility and toughness without brittleness which has heretofore been a feature of hard rubber after a certain period. Besides these it also possesses the advantage over all processes in the comparative ease and rapidity with which it can be sawed, cut, worked in a lathe, etc. Not the least of all these advantages claimed is the economy in the method of manufacture, which is a great saving in labor that the company is willing to divide with its customers in the reduction of prices heretofore obtained. The company has extended its works and added more improved machinery, which permits it to make articles for the electrical trade with promptness. The company is so sanguine of the wonderful improvements in their specialties brought about by Mr. Wm. Kiel's inventions that he is ranked with the pioneers Goodyear and Day, inasmuch as he has been able to produce this product with its many improvements in a way that was formerly deemed to be impossible.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Alternating Apparatus.—Can you tell me what book one can get that will give a complete account of the Thomson-Houston alternating system? B. F. F.

We regret to state that there is at present no book which gives full and practical information regarding any system of alternating current apparatus. The descriptions are usually very general rather than practical. For the Thomson-Houston system, would advise you to write to the company for such descriptive matter as they may have.

Iron Poles for Electric Wires.—Can you tell me how great a demand there has been this season for iron poles for electric lighting and electric railway work? W. A. N.

There has been a considerable demand for iron poles on account of their durability and neat appearance. People are gradually coming to recognize their merits as they see the results of line work put upon them, especially in the case of street railroads. We know of a single electrical engineer who has had orders for more than 5,000 within the last two or three months, and he is one of a number.

Calculating the Size of Wire.—How can the size of wire necessary to carry a given current be readily computed? I am told that in the case of copper 600 circular mils to the ampère is a reliable rule. Is this correct? G. I. J.

The safe carrying capacity of wire depends very much on the chance for cooling that the wire has; for instance, the same rule would not safely apply to armature wire and to line wire. The figure you mention is a safe one for small wires. You will find the carrying capacity of different gauges of wire very well given in va-

rious wire tables. One of the best and most convenient we know of is to be found in the general catalogue of the Electrical Supply Company, Chicago.

Triple Arc Lamp.—(1) Of what does the triple arc lamp consist? (2) What is the double fixed carbon? A. C. S.

(1) The triple carbon arc lamp uses two common round carbons placed parallel and very close together in a special carbon holder. This is for the positive side of the arc. For the negative carbon a single rod is used, in section something like the figure 8. The arc forms between one of the upper carbons and the corresponding side of the duplex lower carbon, and from time to time, as the lamp feeds, shifts back and forth between the upper carbons and from side to side of the lower one. Inasmuch as all three carbons are kept highly heated at their points by the arc, the shifting is accomplished with very little disturbance, thus avoiding the difficulty that was encountered years ago in attempting to use double upper and lower carbons fitting in the same holder. The whole arrangement, as you can see, consists of two closely parallel positive carbons working on a single rather broad negative rod. The result is a long life without retrimming. (2) We presume that the double fixed carbon you refer to is such an one as above described.

Business Notices.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Co., of 105 South Warren street, Syracuse, N. Y.

To All to Whom these Presents May Come, Know Ye.—By a resolution duly passed by the corporation known as "Hazazer & Stanley," it was voted to change the name of said corporation, with permission of the court, from "Hazazer & Stanley" to "Stanley & Hall."

Now, by order of the Supreme Court, it is made known that from this time the name of said corporation is and shall be "Stanley & Hall." A. F. Stanley, President.

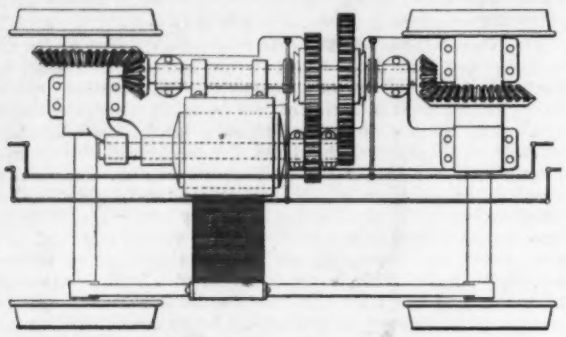
Through Vestibuled and Colonist Sleepers Between Chicago and Tacoma, Wash., and Portland, Ore.—The Wisconsin Central and Northern Pacific lines run through Pullman vestibuled and Colonist sleepers between Chicago and Tacoma, Wash., and Portland, Oregon. The train known as the "Pacific Express" leaves the Grand Central Passenger Station, at the corner of Fifth avenue and Harrison street, at 10:45 P. M. daily. For tickets, berths in Pullman or Colonist sleepers, etc., apply to Geo. K. Thompson, City Passenger and Ticket Agent, 205 Clark street, or to F. J. Eddy, Depot Ticket Agent, Grand Central Passenger Station, corner Fifth avenue and Harrison street, Chicago, Ill.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED SEPTEMBER 23, 1890.

436,777. Mechanical and Electrical Railway Signal; Benjamin R. Davidson, of Fayetteville, Ark. Application filed March 29, 1890. A base, a curved guide mounted on the base, a rotary vertically movable standard operating a semaphore and carrying an arm engaging with the curved guide, and mechanism operated by a train for raising said standard.

436,779. Electric Motor Car Truck; Elbert W. Goss, of Amesbury, Mass. Application filed March 17, 1890. In a truck for electrically propelled vehicles, the combination, with two car axles, each provided with a bevel gear, and a motor shaft ar-



No. 436,779.—Electric Motor Car Truck.

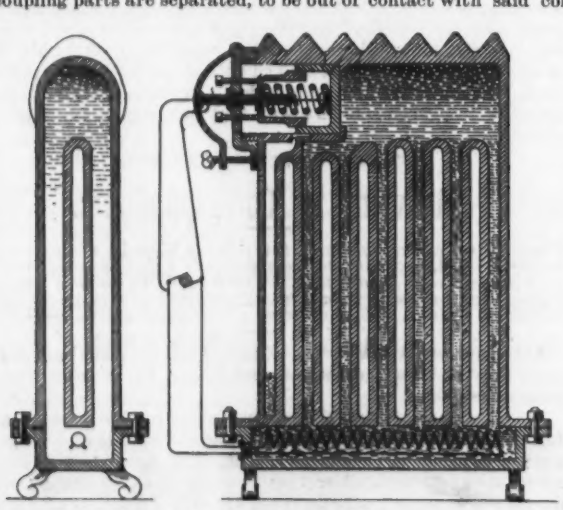
ranged at right angles to the axles, of a countershaft carrying a bevel pinion at each end engaging, respectively, with the gears on the axles, differential intermeshing gearing arranged directly upon the motor and countershafts, the gears in the countershaft being loose thereon, and clutches on the countershaft for connecting and disconnecting the respective loose gears with their shaft.

436,804. Electric Osteotome; Milton Josiah Roberts, of New York, N. Y. Application filed Dec. 4, 1889. In combination, an electric motor, a handle or hand piece in substantially the the same axial line as the motor at the one end thereof, by which the motor is held and controlled, an armature or motor rotating shaft arranged to pass longitudinally through said handle for operating the tool to be worked, and a circuit opening and closing switch connected with the motor outside of the handle and to one side of it for operation by a digit of the hand which grasps the handle.

436,814. Electric Arc Lamp; Auguste Wagniere, of Los Angeles, Cal. Application filed Jan. 28, 1890. In an electric arc lamp a cut-out coil, connected with the helices, in combination with an armature lever, a wire, extending at right angles from the lever, a plate, with which the wire is adapted to make contact, and a wire connecting the plate with a resistance coil.

436,843. Electric Controller for Power Mechanisms; Robert D. O. Smith, of Mishawaka, Ind. Application filed June 26, 1889. In an electrical let-off or releasing gear, a stop and pawl, provided with an extended arm and a counter weight, a vertical momentum rod having a projection to engage said arm, and having a pin, a hooked lever to engage said pin at the point of the hook below the lever, and a latch, combined with an electro-magnet and battery circuit provided with one or more circuit closers.

436,857. Coupling for Electric Wires; Forrest R. Jones, of Kearney, Neb., Assignor of one-half to James G. White, of New York, N. Y. Application filed May 22, 1890. In an electrical coupling the combination of two intermembering coupling parts formed of nonconducting material, a metallic contact piece disposed within each of said coupling parts, and electrical conductor united to each of said contact pieces, and a metallic spring secured to each of said coupling parts, and adapted, when the coupling parts are separated, to be out of contact with said con-



No. 436,864.—Electric Heater.

tact pieces, and when the coupling parts are united, to form contact with each other and each with its appropriate one of said contact pieces.

436,864. Electric Heater; Ernst Abshagen, of Chicago, Ill., Assignor by direct and mesne assignments of five-eighths to Alfred W. Brewerton, George M. Clark, Henry M. Hubbard, and Wm. H. Hubbard, all of same place. Application filed May 14, 1890. In an electric heat generator, a resistance piece covered with a non-conductive fluid, such as oil, lard, or its equivalent.

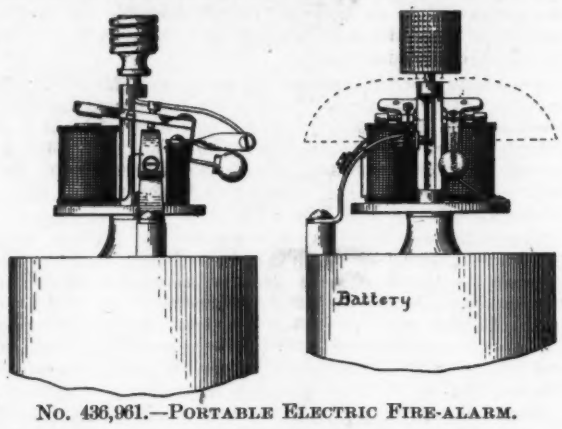
436,874. Electric Contact Device; John J. Hoppes, of Springfield, O. Application filed Jan. 30, 1890. The invention consists in a jointed or flexible trolley arm, a portion of which is adapted to assume an unusual position, which shall cause the supporting mechanism to be released and permit said trolley to drop free of the conductor in the event that the trolley wheel becomes removed from the track.

36,895. Process of Electro-Depositing Aluminum; John A. Leancon, of Newport, Ky. Application filed Dec. 30, 1889. The process of electro-depositing aluminum, consisting in subjecting a supersaturated acid solution of an oxysalt of aluminum in water to the action of an electrolytic current passed through the electrolyte between an anode plate of aluminum in a state of diversion or porosity, presenting a relatively large exposure of surface within a given field of electrolytic force and a suitable metallic cathode to be plated.

436,901. Speed Regulators for Dynamos; Samuel E. Nutting, of Chicago, Ill. Application filed Dec. 30, 1889. In an armature speed regulator, the combination of an electro-magnet, a hub rotatable with the armature and provided with a frictional surface, a pulley rotatable independently of the armature and provided with a frictional surface, such frictional surfaces bearing against each other in a chamber filled with a lubricant, and being brought to different degrees of frictional contact to vary the speed of the rotation of the hub according to variations in the resistance.

436,923. Electric Railway; Hosea W. Libbey, of Boston, Mass. Application filed Nov. 11, 1889. In combination with a rail for electric railroads, having a vertical groove formed in its flange, the groove being rounded at its bottom and of equal width throughout, spring clamps for holding the electric wire near the bottom of the groove.

436,944. Grooved Switch; Wm. Henry Seward Wright, of Elkhart, Ind. Application filed June 3, 1890. An electric switch, consisting of a plate connected to the conductors and having a



No. 436,961.—Portable Electric Fire-alarm.

central longitudinal guide block extending throughout the length of the plate.

436,952. Thermal Cut-Out; George Herbert Whittingham, of Baltimore, Md., Assignor to the Automatic Electric Switch Company, of same place. Application filed July 1, 1889; renewed Feb. 20, 1890. In an electric fuse, the combination of a ribbon of fusible material with a pair of conducting clips which form the terminals of an electric circuit, and a spreading device suitably mounted to pass between said clips and carrying the fuse ribbon in position to be engaged by the first clip when the spreader has passed through it, and to be held by said clip as the ribbon is drawn from the device carrying it and passed by the spreader through the second clip.

436,961. Portable Electric Fire-Alarm; Francis R. Upton, of Orange, N. J., and Fernando J. Dibble, of Peabody, Mass. Application filed March 24, 1890. The combination, in a portable fire alarm, of a battery, a plate on one pole supporting a bell-magnet

No. 436,964.—Commutator Brush.

and an insulated circuit terminal, a central post carrying the bell dome, a thermostatic coil, said coil being connected to the contact co-operating with the insulated circuit terminal, and a terminal supported on the second pole of the battery.

436,964. Commutator Brush; Charles Wirt, of Orange, N. J., Assignor of one-half to Francis R. Upton, of same place. Application filed April 12, 1890. A commutator brush comprising in combination a central strip of good conductivity and on either side thereof a strip of poor conductivity, the ends of all the strips bearing simultaneously on the commutator cylinder.

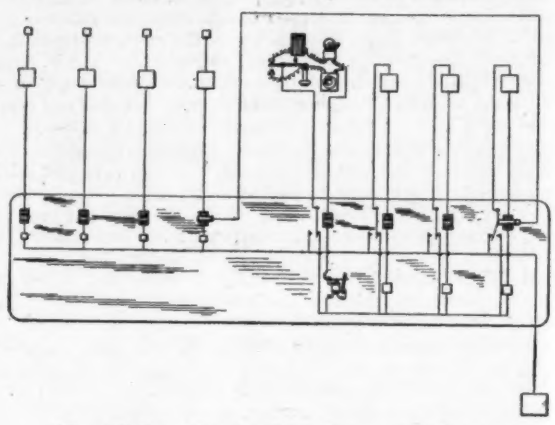
436,979. Electric Signal for Velocipedes; Charles G. Jiran, of Chicago, Ill. Application filed June 30, 1890. The invention consists in combining with the seat and steering appliance and brake of a velocipede an electric battery, an electro-magnet and armature, an insulated circuit wire, a contact spring and a bell.

437,010. Telephone Exchange System; Edward M. Bentley, of Boston, Mass. Application filed Nov. 2, 1889. A local telephone exchange having a series of radiating lines, with a common return line connected to their outer ends, the said return line having a ground connection at a point outside the area of leakage disturbance.

437,011. Artificial Resistance; Edward M. Bentley, of New York, N. Y. Application filed Aug. 25, 1888. The invention consists of a series of metallic plates in superficial contacts, which form the resistance, and which are provided with a series of contact points electrically connected to certain ones of the series of plates, and a contact arm adapted to make a connection with the points to bring any desired amount of the resistance into circuit.

437,012. Telephone Exchange System; Edward M. Bentley, of Boston, Mass. Application filed March 8, 1890. The invention consists in bringing both terminals of the metallic circuits into the central station, where one end of each circuit is provided with the ordinary plug-socket or other connecting device for putting it in circuit with other lines, while the other end is connected to a switch which rests normally against a common insulated conductor at the central station, but which may be moved to break the connection with the said common insulated conductor and establish connection with a grounded conductor.

437,044. Method of Impregnating Parts of Electrical Apparatus; Frederick L. Rawson, of London, England, Assignor to the Company Woodhouse & Rawson United, Limited, of same place. Application filed Jan. 29, 1890. The method of preparing bases and other insulating parts of electrical apparatus, consisting of hydraulic cement molded to shape, which consists in the impregnation of the same from inside with heavy oily or resinous matter by putting a closed heated vessel inside the



No. 437,012.—Telephone Exchange System.

molded article in such a manner that spaces are left all around it to receive the impregnating substance.

437,079. Electric Belt; Lewis D. Ashbrook, of Cardington, O. Application filed May 15, 1890. In an electro-galvanic belt a cell, consisting of two metallic U-shaped plates, presenting terminals having integral tongues folded to form eyes, and means for connecting the plates and absorbent pads together.

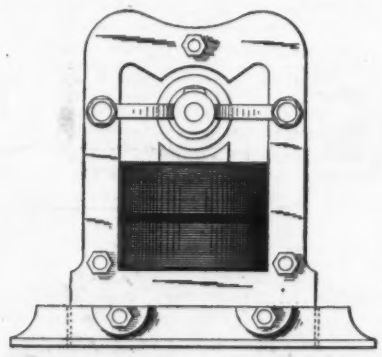
437,111. Rheostat; Josephus Henry Gunning, of New York, N. Y. Application filed Nov. 15, 1889. The invention consists in the combination, with a tapering resistance piece formed of a conductor or semi-conductor, of a roller adapted to roll upon the tapering plate from the narrower to the wider end or in the reverse direction, and means for moving the said roller gradually and uniformly.

437,116. Coupling for Electric Wires; James J. Hinphey, of Bound Brook, N. J., Assignor of one-half to Benjamin B. Matthews, of same place. Application filed March 5, 1890. The combination, with a metal block, which is an electric conductor, having a portion of its body reduced on one side to form an offset, an insulating slab imposed upon the thick portion of the block, and electric conductor plate on said insulating slab, a longitudinal slot intervening said block and slab, and means for securing said block, plate and slab together, of a spring actuated plug adapted to electrically connect the block and conductor plate when said slot is open.

437,126. Underground Electric Conduit; Charles Edward Loth, of Troy, N. Y. Application filed Dec. 17, 1889. The combination with a rack having longitudinally extending bracket receiving ways and a longitudinally extending slot of a support secured at one end in said slot and a swinging tension lever mounted on said support.

437,158. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Electric Car Company of America, of the same place. Application filed Sept. 23, 1886, June 1, 1887, and March 24, 1888. In an electrically propelled vehicle, the combination of an axle, a worm wheel secured thereon, a rotary shaft arranged longitudinally upon the vehicle, a worm of said shaft meshing with the worm wheel, an electric motor armature secured to and concentric with said shaft, a commutator for the armature, a bearing for the shaft journaled on the axle, and stationary magnets inclosing said armature carried by the vehicle and under the body thereof.

437,160. Dynamo Electric Machine or Motor; Max Mayer, of New York, N. Y., Assignor to David Hirsch, of same place. A dynamo or motor consisting of base plates in two parts



No. 437,160.—Dynamo-electric Machine.

which, when placed together form a rectangular frame, laminated iron plates whose lower ends are located in said frame and bolted thereto and to each other, each plate consisting of uprights, connected at their upper ends by cross-pieces and provided with central projections, magnets located on said projections, extensions, bolts, which pass through the field magnet plates, and cross bars, connecting said extensions and carrying an armature shaft, of which the armature is located between the projections and cross pieces.

437,168. Clock Synchronizer; Arthur G. Wiseman, of Webster Groves, Mo. Application filed Oct. 19, 1889. In a time piece, the combination of the second hand shaft, the second hand, and the spiral arm and striker, said spiral arm curving around a complete circuit and in its operation always moving in a forward direction.

Copies of the specifications and drawings complete of any of the patents mentioned in this record—or of any other patents issued since 1886—can be had for 25 cents. Give the date and number of patent desired, and address The W. J. Johnston Co., Ltd., Times Building, N. Y.

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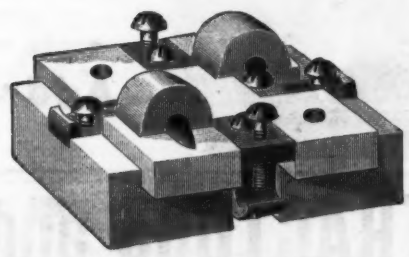

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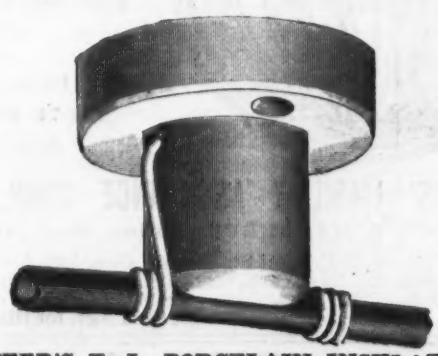

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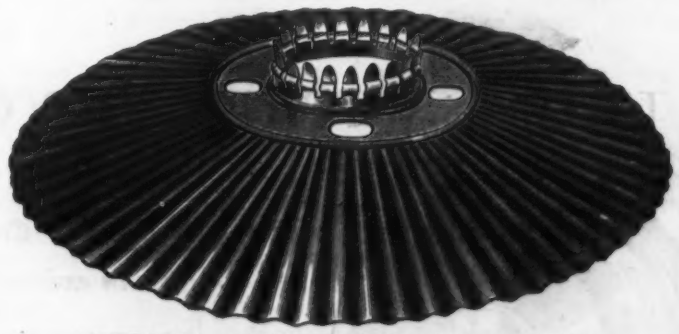

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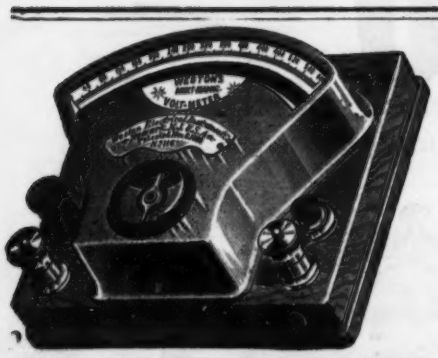

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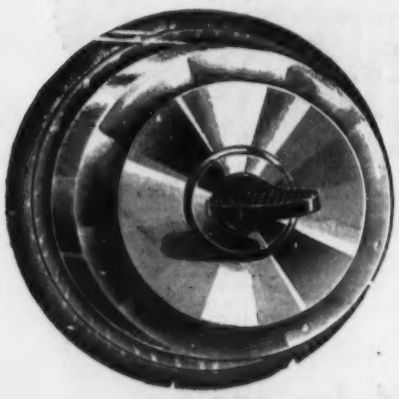

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W. B. PEARSON,
Mechanical Engineer and Contractor of Electric and Steam Plants, Room 436, Rookery Chicago.

With an order from Daniel Shaw Lumber Co Eau Claire, Wis., dated June 16, 1888 they say "The dynamo belt sent us is a "Jim Dandy."